TOPICS OF THE MONTH

Waste not, want not

REVIEWING America's natural resources of land, minerals, forests and water, a report from the Twentieth Century Fund strongly urges sparing use and intelligent conservation of basic assets. On the other side of the equation, the report says: ' Yet we have more, much more, than simply a central store of raw materials which, once used up, will be gone for ever. Out of our laboratories and factories comes a steady stream of fibres, substances, materials created to order. It is almost literally true that if you give the specifications of any wanted material—strong as steel, flexible as rubber, light as balsa, washable as cotton, heavy as lead, hard as a diamond—in any combination, technology will create it for you. And modern technology will use such ingredients as air, water, sand, vegetable pulp, and metals from the sea, which are available in almost limitless quantities.'

All of which only helps to add to the confusion, as well as the self-esteem, of the scientist who, firm in the belief that matter is indestructible, but on the other hand beset by stories that resources of this or that valuable material are dwindling, is trying to make up his mind what ought to be done about it all.

Perhaps he will see a glimmer of light in the conclusions of a panel of scientists which recently met in Canada, under the auspices of the Royal Society of Canada, as part of a three-day symposium on Canada's human and material resources. Acknowledging that a precise and complete inventory of mineral resources cannot be made, they agreed that, as known at present, total reserves are large, but the supply of individual materials varies greatly and they cannot be treated alike. Should we attempt to conserve some or all of those we have, they asked, or, alternatively, can we hope to replace those we use by new discoveries? Although there was a debt to future generations of Canadians, there was also a present one to the ' free ' world, in need of raw materials. This was the dilemma.

It was resolved that, unless new methods for discovering minerals are found, the depletion of accessible deposits of the rare metals seems inevitable. The trend must be toward increased use of those metals which constitute a major portion of the earth's crust. These are aluminium, magnesium, iron and titanium. With the exception of iron, they are reactive metals whose production requires large amounts of ' high level ' energy which is supplied at present as electrical energy.

The panel also observed that the trend to remote hydro-electric locations will continue until these sites are saturated, after which nuclear power may level the cost of electrical energy throughout industrial nations. With electrical energy available and ubiquitous metals such as aluminium, magnesium, and iron available, the favoured positions occupied by certain nations will be somewhat diminished.

Hydrogenation in the coal-tar industry

WITH the building of a pilot plant in Britain for refining crude benzole, naphthas and other hydrocarbon oils, using a process which is claimed to have many advantages over conventional processes, we see the emergence of hydrogenation as a chemical engineering tool of great potential value to the coal tar industry. The new process differs from other refining processes for crude benzole by employing a considerably shorter contact time. In this way there is a higher output obtained for a given size of converter, and operation for naphtha refining is at considerably lower pressures. Thus, consumption of hydrogen in naphtha refining is much reduced and the undesirable conversion of aromatics to naphthenic hydrocarbons is minimised.

The erection of the plant at Thorncliffe, near Sheffield, is the first result of an agreement between Newton Chambers & Co. Ltd. and the Coal Tar Research Association. The hydro-refining process has been developed for continuous operation as a result of research carried out by the Association since 1952 and now the company have acquired world rights for manufacturing the plants to operate the process. Pure hydrogen or hydrogen-containing gases such as coal gas or coke-oven gas are used in combination with a particular catalyst for the preferential hydrogenolysis of sulphur compounds, gum-forming olefines and colour-forming bodies.

At present the refining of benzoles and naphthas is carried out almost universally using a batch/intermittent process of agitation with strong sulphuric acid. Newton Chambers point out that, in addition to the somewhat uncertain results, the acid-washing process results in considerable losses of spirits and the production of ' acid tar,' disposal of which is extremely difficult. Moreover, naphthas cannot always be satisfactorily refined by washing with strong sulphuric acid.

It is worth noting that the new pilot plant has been designed for wider operating conditions than those required for the hydro-desulphurisation of benzoles and naphthas so that it can be readily adapted for further investigations and development work in this field.

Newton Chambers are an old company—they were established in 1793—with a lot of experience as engineers as well as ironfounders and chemical manufacturers. Chemical engineers who know them for their *Lithcote* linings will be interested to see this new venture into the coal tar field.

Titanium turns to chemical engineering

WHILE titanium has been extolled, for some time past, as a potential and actual material of construction for chemical plant, there has been a feeling that it is likely to be some time before there is a good supply of this metal at a reasonable cost for the many applications in chemical engineering where its corrosion resistance and strength are in demand. There are now hopeful signs that not only is titanium easier to get but that fabrication techniques have made great strides and that it need not necessarily be an expensive material.

To take just one recent example, a titanium-lined, mild-steel vessel is stated to be of the same order of cost as one completely in stainless steel for the same service. This is a vessel 4 ft. long and 4 ft. in diameter, the lining (attached by a spot-welding technique) providing the corrosion resistance while the shell provides the strength. The construction of this vessel also shows that the sheet can also be manipulated to line branch pipes and domed ends.

Another example is a Mitchell shrouded pump impeller which was covered with commercially pure titanium sheet. Other smaller impellers have been machined from solid titanium, this being an application in which the great erosion and corrosion resistance of the metal come to the fore. In valves and pumps, too, titanium is being used increasingly. Valves employing titanium include ¼-in. high-pressure needle valves in titanium alloy for handling a variety of corrosive gases, while cast-iron, type-A Saunders valve bodies have been lined with titanium sheet and a valve of 2-in. bore has been made in welded titanium for use in equipment handling wet chlorine.

In the chemical industry, one application in which titanium mesh is expected to find considerable use is in filters for handling chemicals, while in the paper industry titanium mesh is useful for handling pulp.

These and numerous other applications of titanium were recently displayed in London by Imperial Chemical Industries Ltd., the fabrication of the welded items shown having been carried out by Marston Excelsior Ltd. This seems to give hope that we shall hear much more of the practical applications of titanium in the chemical and allied industries in the future.

Glycerol problems

CURRENT American estimates suggest that within another year or so glycerol will be yet another 'natural' chemical to be displaced by synthetic material.

In 1949 about 10% of the U.S. glycerol production was synthetic in origin and by 1956 this proportion had grown to more than 40%. The larger part of this growth had been absorbed by increasing demand, but for the same years the overall production of natural glycerol had fallen by nearly 20%.

Undoubtedly, this position has been influenced by the decline in the demand for fatty soaps consequent upon the increasing use of synthetic detergents. It is reported, however, that since the decline in the demand for fatty soaps is now levelling off, the production of natural glycerol will remain reasonably steady from now on.

Phthalic alkyd resins are still the largest single market for glycerol, but these resins face strong competition from penta-erythritol alkyds. The U.S. production figures for these resins in 1955 were: glycerol-based 325 million lb., and penta-erythritol-based 265 million lb.

While glycerol has maintained its importance as a plasticiser for regenerated cellulose, it has lost ground to other glycols in the field of tobacco humectants. In the explosives field, too, glycerol has lost importance, since the use of nitroglycerine is challenged by a number of other chemicals.

International element

THE new element—element 102—which has recently been discovered is notable as representing the first discovery of its kind to be made by an international research team. Indeed, the new element, which now takes its place at the end of the sequence of known elements standing beyond uranium in the atomic table, is the first element in the series to be discovered in Europe, the remainder having been discovered in the United States.

It was a joint research effort by scientists from Sweden, Great Britain and the United States which led to the discovery of element 102. It was produced by bombarding curium, which is element 96, with carbon ions accelerated in the 225-cm. cyclotron at the Nobel Institute, Stockholm.

Element 102 was identified among the products on the capture foil by radiochemical methods; the isotope identified had a half-life of about 10 min. and emitted alpha particles with 8.5 MeV. energy. The isotope probably has a mass of 253, but this has not yet been established with certainty.

Ion-exchange waste recovery in plating plant

A GOOD example of the cost-saving advantages of ion exchange for treatment of plating wastes is provided by an American plant for plating copper, nickel and chromium on motor trim. In addition to conserving plating metals and acid, the plant recovers a considerable proportion of the water used in plating operations. Furthermore, the recovered water is completely deionised and this, in turn, reduces the cost of chemical treatment of the boiler feed. By recovering both the plating wastes and the water, the cost of waste treatment has been brought down to very nearly the break-even point.

The plating waste recovery system consists of three pairs of cation and anion exchange columns, one pair for each type of waste. The cation exchange columns contain *Amberlite* IR-120, a strongly acidic resin, while the anion exchange columns contain *Amberlite* IRA-410, which is a strongly basic resin. Details of the plant were given in *Electroplating and Metal Finishing* (1957, **10** (4), 116-118), which records that in six months a monthly average of 2,000 lb. of nickel

sulphate (dry weight), 500 lb. of copper sulphate, 500 lb. of 66° sulphuric acid and 15,000 lb. of barium chromate were recovered. Some 25% of used water was being recovered and plans for greatly increasing this figure were progressing.

Stainless steel uses and problems

STAINLESS steel is a material of construction which is in great demand in a number of industries and, in view of the protracted deliveries experienced in Britain at present, those chemical engineers who are more concerned with its use in handling chemicals may view with some misgiving the increasing popularity of this metal with others who are more concerned with its advantages in food-processing equipment. However, we are assured that the supply position is getting better, and so we can look dispassionately at a special illustrated supplement in our associate journal *Dairy Engineering* for this month, in which stainless steel is viewed from many aspects as a material of construction for dairy plant and equipment of all kinds. It is interesting to note that increasing use is being made of stainless steel not only for milk processing equipment, storage tanks and dairy pipelines and fittings, but also for such items as butter churns, where wood has served hitherto, and for cream and cheese vats, while the dairy and food industries vie with the chemical industries in their increased demand for stainless-steel centrifugal pumps. The attractive appearance, as well as the hygienic qualities of stainless steel are an influence on its use in the dairy industry, much more publicity-conscious today than hitherto.

In this enterprising *Dairy Engineering* supplement, one contribution, from a pump manufacturer, gives some hints on obtaining good stainless-steel castings, while another, by the president of the Food Machinery Association, Mr. J. S. Clayton Marshall, comments that the supply position—sometimes up to 40 weeks are required for the execution of an order for standard sheets, sections and bars—causes problems.

Two interesting points are made from the plant fabricator's point of view by Mr. J. F. Lancaster, until recently chief metallurgist of A.P.V. and now with Kellogg International Corporation. The first concerns the chromium-nickel-manganese austenitic stainless steel which appears to have considerable possibilities in the dairy field and which, because it economises in nickel, ought to be widely used. Unfortunately, Mr. Lancaster points out, in one at least of the commercially available forms of this steel the carbon content is such that it is sensitive to ' weld-decay ' attack. He makes a plea for the development of a stabilised or low-carbon form which could be welded without fear of subsequent corrosion. The other point he makes is about surface finish, important to dairymen, and he points out that a cold-rolled finish which can be mirror-polished with the minimum of effort is available in the United States. More rapid development in Britain, he urges, would be of great help to fabricators who want to make dairy equipment with a better finish but at reasonable cost.

British oil-gas process for Eastern Germany

AN indication of the improved trade relation between Eastern Germany and Great Britain is provided by the announcement that the Power-Gas Corporation Ltd., in association with licensees in Germany, Didier-Werke A.G., Essen, have received an order for two units of *Segas* plant, each of 30,000 cu.m./day for the gasworks at Rostock, Eastern Germany.

Although Didier-Werke have already installed *Segas* plants in Western Germany at Hameln and München Gladbach, this is the first order for this type of plant to be received from Eastern Germany. A considerable part of the plant is to be supplied from the Stockton works of Power-Gas.

The *Segas* catalytic oil-gas process is capable of handling a wide variety of feedstock: heavy and light fuel oils, gas oil, low-grade petrol, liquefied petroleum gases, and in the case of Rostock the feedstock is a brown coal tar. It is valuable as base load or peak load plant and possesses great flexibility as a gas-making unit. The residual tar can be handled easily and sold or burnt as fuel.

Coatings from fish oils

ALTHOUGH relatively inexpensive, marine oils have had very limited application in the field of protective and decorative coatings. It is generally agreed that fish oils give soft, flexible films which bloom and yellow badly when not chemically processed. However, in addition to their low cost, these oils have the advantages of resisting decomposition by heat and giving better results in rust-proofing paints.

The rather peculiar behaviour of fish oil (sardine type) during and after treatment with maleic anhydride and pentaerythritol was the subject of a recent study by R. A. Troupe and M. A. Aia, of Northeastern University, Boston, Mass., U.S. A bleached, refined fish oil of low acid value was used as the starting material and commercial maleic anhydride having a minimum purity of 99% and technical pentaerythritol was used for the modification of the oil. The procedure followed was similar to that which has been practised commercially on several types of oils including fish, soya and linseed oils. Essentially the apparatus consisted of a 1-litre, three-neck flask equipped with a variable-speed agitator, Dean-Stark tube, Allihn condenser, thermometer and a glass tube through which inert gas (CO_2 or N_2) was bubbled. Heating was by an electric heating mantle regulated by a variable-voltage regulator.

A number of runs were made and one result was to show that heating requirements decrease sharply not only with increasing modification but also with increasing viscosity.

It was found that maleinisation decreases the time and heat required to kettle to a desired viscosity, other things being equal. Another feature was that top temperatures just slightly above 500°F. were sufficient. Unmodified fish oil usually requires considerably higher temperatures. It was also found

that processing without inert gas substantially increases cooking time and heating requirements, even at a high concentration of 5.5% maleic anhydride.

These experiments, which have been reported in the *Official Digest* (March 1957) of the Federation of Paint and Varnish Production Clubs, indicate that processed fish oils may have possibilities as replacement for part of the more expensive vehicles of both interior and exterior paints. The best application seems to be in rust-inhibitive metal primers to replace a portion of the linseed oil.

Welding discoveries

A NEW, 13,000-sq.ft. metallurgical laboratory block was opened by the British Welding Research Association on July 23 and guests were able to see demonstrations of the latest welding processes and control tests. The laboratory, which is situated at Abington, near Cambridge, includes a welding laboratory with an impressive range of equipment for the metal-arc and gas-shielded welding processes; an instrument room; a heat-treatment room; a general laboratory housing the mechanical testing equipment and all other apparatus of common interest to the various research groups; a metallographic section; an alloy steels section; an analytical laboratory; and a reactive metal laboratory.

In the reactive metal laboratory, the welding characteristics of titanium and zirconium alloys are being investigated. Special problems in welding reactive metals in the 'open air' are also being examined. Zirconium and titanium are readily contaminated by traces of oxygen, nitrogen and hydrogen. The properties of welds, entirely free from contamination, are obtained from test welds made in a chamber which can be evacuated to 10^{-5} mm. Hg and filled with high-purity argon. Material for welding may be annealed or treated for hydrogen removal in a vacuum annealing furnace designed to work up to 1,000°C. at 5×10^{-5} mm. Hg. An autoclave has been acquired for the corrosion testing of zirconium-alloy welds in high-temperature water or steam.

Weld defects which can sometimes be encountered with titanium alloys were illustrated. Cracking can result from atmospheric contamination or a high hydrogen content in the material being welded. Porosity can be caused by argon entrapped within the weld.

The visit to the new laboratories gave the opportunity of seeing the important work that is being done on the welding of pressure vessels and pipelines. One example of this is the experimental work for an investigation on the reinforcement of pipe branch connections, which has recently been completed. Twelve welded branch connections were included in the programme as well as seamless welding tees and, for each type, stress distributions were measured under five distinct forms of loading. The conventional collar reinforcement is shown to be reasonably effective but it can be slightly improved on by the 'triform' reinforcement.

Work on gusseted pipe bends includes measurements of stress distribution which have been carried out on two-weld and three-weld specimens, and severe bending tests have failed to show welds as a source of weakness. Indeed, for a given moment, the stresses close to a weld in a gusseted bend are slightly higher than in a corresponding smooth bend.

A discovery that has been made concerning the reinforcement of branch connections in pressure vessels arose out of previous work which included the measurement of stress distribution around branches attached to a 42-in.-diam. vessel with a wall thickness of $1\frac{5}{8}$ in. Some of the branches were provided with reinforcing plates, the dimensions of which were calculated in the conventional manner, and others had no reinforcing plates. A method of calculating the maximum stress intensification factor for branches without reinforcing plates was developed. This indicates that, as the vessel thickness is increased relative to its diameter, so the necessity for reinforcement decreases. If this can be proved to be correct experimentally it would be most important in industry.

Effluent experts visit chemical works

A REMINDER of the important work now being carried out in developing methods of effluent disposal is provided by the recent visit of the A.B.C.M. Trade Effluents Committee to Aero Research Ltd. The problem of efficient disposal is nation-wide and Aero Research, situated at Duxford near the River Cam some nine miles south of Cambridge, have benefited from the investigations they have conducted as manufacturers of urea-formaldehyde, phenol-formaldehyde and melamine-formaldehyde resins and adhesives. These resin manufacturing processes give rise to liquid organic wastes containing, among other substances, formaldehyde and methanol in solution with traces of sticky resin in suspension.

At Duxford there is an impressive drainage system and a storage lagoon, adjoining the treatment plant, acts as a large balancing tank for the factory waste water which is bactericidal in character. The waste water is pumped from the lagoon at a controlled rate, diluted with clean water and treated in a diffused-air-activated sludge plant in conjunction with settled domestic sewage. Surplus activated sludge which is produced is discharged to an adjoining field. Domestic sewage sludge is discharged to drying beds. The activated sludge plant effluent is chlorinated and passed to a storage and balancing pond. The pond effluent is diluted with surplus clean condenser cooling water, discharged to a ditch about half a mile long and finally flows into the River Cam.

Part of the activated sludge plant effluent is diluted with clean water and fed on to two 40-ft. diameter experimental biological filters. B.O.D. filter loadings similar to those normally employed with settled domestic sewage give filter effluents which, when settled, have a B.O.D. of less than 20 p.p.m. The seasonal variation in performance of these filters is at present under investigation.

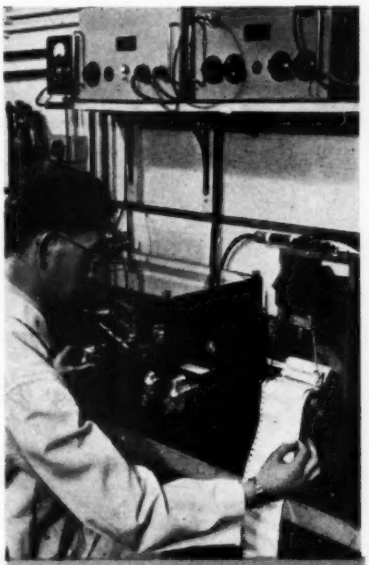
Infra-red Absorption Analysis as a Process Tool

By R. Quarendon, Ph.D., B.Sc.

Infra-red absorption analysis occupies a foremost place in the rapidly developing use of physical methods of analysis in the chemical industry, both in the laboratory and on the plant itself, especially for the continuous monitoring of process streams. This article reviews briefly the various features which make it attractive as a process tool, including a description of the various types of equipment which are available, followed by references to particular applications, and the possibilities of its use for the automatic control of process operations.

THE outstanding characteristic of infra-red absorption analysis which distinguishes it from most other physical methods of analysis, and therefore gives it a wider field of usefulness than, say, thermal conductivity or refraction of light, is its inherent selectivity and discriminating power. This greater versatility arises from the uniqueness of the absorption spectrum of most chemical compounds, of which only practical limitations of technique prevent the fullest use being made. In this respect it is being challenged by gas chromatography and to some extent by nuclear magnetic resonance, but these two techniques have not yet acquired the status that has been attained in practical application by infra-red absorption analysis. In the allied fields of analysis using visible and ultra-violet radiation the relatively featureless nature of the absorption spectra offsets the practical advantages of the more powerful energy flux available for measurement. The highly individual nature of the infra-red absorption spectrum of a substance enables it to tackle successfully problems for which no alternative solution had previously been found, or where alternative methods were too slow or inaccurate.

Another valuable feature of light-absorption methods in general and infra-red absorption in particular is the increase in sensitivity which can in theory be obtained as the concentration of absorbing constituent in a mixture decreases, and which therefore gives the method great interest for the analysis of trace constituents of a mixture. With the development of more sensitive detectors and more powerful amplification systems coupled with improved instrument design, increasing use is being made of this feature. The sensitivity which can be obtained depends upon the nature of the substances present in the mixture as well as upon the design and properties of the apparatus employed. Similarities between the infra-red absorption activities of members of the same general class of substance, for example saturated hydrocarbon gases, have tended to restrict the usefulness of the infra-red absorption technique, but steady progress in instrument design is removing these obstacles and opening up new fields of usefulness.



The Grubb-Parsons S.3 apparatus, which is used mainly for spectroscopic analysis in research problems, seen in the analysis and oil chemistry section of the Thornton Research Centre.

Infra-red absorption can be used for the analysis of gases, liquids or solids, the complexity of the mixture which can be handled depending upon properties of the constituents of the mixture. Its chief practical value lies in the analysis of organic substances, which often lack distinctive reactions which can be applied in a simple way for routine control purposes. When applied to the continuous analysis of process streams, the closer control which it gives may enable the construction and operating costs to be reduced by an amount which soon saves the cost of the instrumentation and its upkeep. It also gives the plant operators a closer interest in the operation of the process, as they can more easily see the changes which are taking place.

Two classes of infra-red analyser

In the past there has been a fairly sharp division of the two types of infra-red analysis instrument into separate fields of usefulness, the spectrophotometer being confined chiefly to the laboratory and the continuous non-dispersive analyser to the plant. The former is a more versatile but less robust instrument not normally suited to use under plant conditions where the dust and corrosive vapours may upset the working of the rather delicate optical system. The non-dispersive analyser is a more rugged piece of equipment capable of withstanding plant conditions. However, in recent years dispersive-type instruments have been produced with protection against these adverse conditions for dealing with problems which cannot adequately be handled by the non-dispersive analyser, so that the line of demarcation between the

two types of equipment is less distinct than it once was. In favourable circumstances, however, the sensitivity of a well-designed continuous non-dispersive analyser can be as great as that of the spectrophotometer.

Development of the spectrophotometer

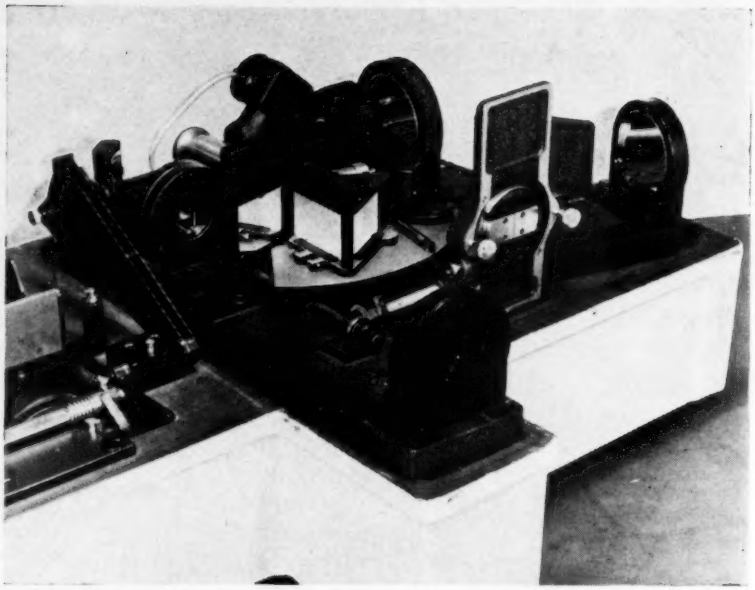
Although the first commercial infra-red spectrometer was produced by the firm of Adam Hilger as early as 1913, it needed the stimulus of the demand for a rapid method for the analysis of aviation petrol during the last war to start the development of the really reliable and practical instruments suitable for use in the industrial laboratory which are now available. It is largely as the result of co-operation between the physicist, the petroleum refinery chemist and the instrument designer that the infra-red spectrometer has been transformed from a research instrument of uncertain behaviour into a reliable and stable piece of equipment capable of producing trustworthy results in the hands of the unqualified laboratory assistant. The forerunner of the modern instrument may be regarded as the spectrometer designed by Brattain and Beeck[1] for the analysis of aviation spirit, which became the basis of the model IR 1 infra-red spectrometer marketed by the Beckman Instrument Co. Britain unfortunately lost the commercial initiative in this field, although it is now making up lost ground.

Types of spectrophotometer

There are two general classes of spectrophotometer in common use: the single-beam instrument which until recent years was most easily available and most favoured for the routine work of the analytical laboratory, and the more elaborate and more expensive double-beam spectrophotometer, better adapted to the rapid plotting of absorption spectra for exploratory work and research investigations. However, the development during recent years of satisfactory double-beam spectrophotometers, especially those designed for single- or double-beam operation at will, and also single-beam double-pass instruments of high resolving power at relatively low cost, has considerably increased the scope of infra-red techniques in the industrial laboratory.

Design of spectrophotometers

There is no need for a detailed description of the design and construction of spectrophotometers, but some reference to the salient features



may be of interest to enable the reader to comprehend the principle on which they operate.

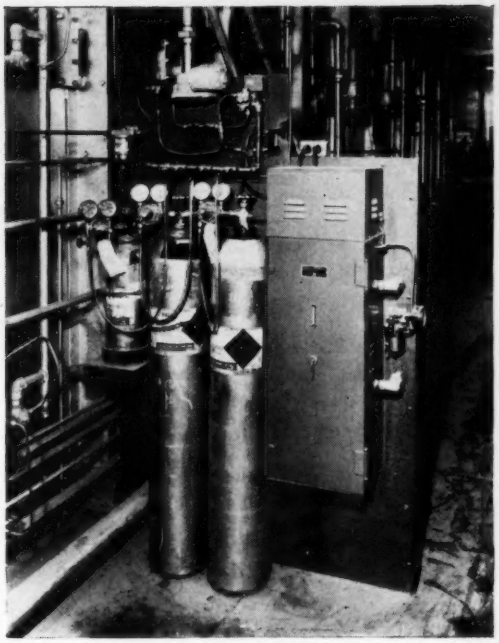
The essential functional units or parts of a typical instrument consist of (i) a source of infra-red radiation, usually either a Nernst glower or a heated nichrome spiral operated at a controlled voltage; (ii) a collimating or condensing system for directing the beam or radiation through the absorption cell; (iii) a filter and absorption cell, which for a liquid may contain a sample as little as 0.01 mm. thick, or with a gas may be as long as 1 m. or more; (iv) a monochromator with prism or diffraction grating for dispersing the radiant beam, adjustable slits for defining the incident and emergent beams, and means of scanning the spectrum for the selection of the desired wavelength at which the measurement is to be made; (v) a detector for receiving the radiation of the selected wavelength after absorption by the sample, and for converting it into an electric signal, usually a very sensitive bolometer or vacuum thermocouple (although photoconductive cells are finding increasing application at the short wavelengths, also the pneumatic Golay and Pfund cells); (vi) a high gain amplifier for producing sufficient signal strength for useful application; and (vii) an indicator or recorder. This enumeration of the different parts is given for ease of explanation, but the order may differ in different designs, and the grouping of the parts may vary. There is also increasing emphasis on design for greater speed and convenience.

Most modern spectrophotometers have 'chopping' systems for interrupting the beam of radiation at a definite controlled rate of modulation, which in conjunction with the use of a tuned amplifier enables the disturbing effects of changes of ambient temperature of zero drift and amplifier gain to be largely eliminated. Some means of rectification of the a.c. output of the amplifier is also provided. Double-beam spectrophotometers often work on the optical null-balance system, in which the rectified output of the amplifier is fed back through a closed loop to an attenuator in the reference beam, bringing it into balance with the test beam. This arrangement provides increased stability.

Since the war great improvements have been made in infra-red detectors. Fast photoconductive cells of lead sulphide, selenide and telluride, sensitive to radiation over wavelength ranges from 1 to a maximum of about 4.5 μ, and thermistor bolometers with response times of 2 to 8 msec. permit the use of very high chopping speeds and enable rapid changes of concentration to be followed. The Golay detector is also very fast and is claimed to have a uniform sensitivity to radiation from the ultra-violet to the microwave region. Achievements in this branch of spectrometry may be realised from the fact that the power available in the dispersed beam may be of the order of only 0.1 μw.

Use of the spectrophotometer

The use of the infra-red spectro-



Left: **Non-recording infra-red spectrophotometer by Hilger & Watts Ltd., showing detail of monochromator.**

Above: **Perkin-Elmer model 13 infra-red spectrometer. An intermediate-price instrument which can be used as a single-beam or ratio-recording instrument.**

Right: **Nil dispersion gas analyser produced by Integra, Leeds & Northrup Ltd. Installation in plant showing calibrating and trim gas tanks.**

photometer for quantitative analysis in the plant laboratory for chemical process control in the manufacture of organic chemicals is spreading rapidly as simpler and more reliable instruments are becoming available at a more reasonable cost. Its value lies largely in its speed for repetitive work once the initial ground work has been done, as in the analysis of mixtures of hydrocarbons and other organics which are difficult to differentiate by other means. For some purposes there is no satisfactory alternative method of analysis suitable for the industrial laboratory. Here it can be of great service in the routine analytical control of process operations, during the various stages of manufacture, and for the assay of raw materials and products. It has been found very useful in the large-scale manufacture of some of the newer organic chemicals such as DDT, 2,4 D and penicillin. Its greatest value is probably realised when it is used in conjunction with other physical methods of analysis, including spectroscopy in other regions of the electromagnetic spectrum.

The choice of instrument naturally depends upon the use to which it is to be put. Probably the most useful instrument if only one is to be purchased is the double-beam recording spectrophotometer which can also be used as a single-beam instrument; it could then be used for making preliminary surveys of the spectra in new applications as well as for routine quantitative analyses by either the single-beam or double-beam techniques according to the circumstances. However, the amount of work may not justify the expenditure of more than the cost of a simple single-beam model. The photometric accuracy of the single-beam instrument is probably greater, and it also has a wider spectral range than the double-beam spectrophotometer. It is also more adaptable in that it can be used with a wider range of auxiliary equipment, such as a microscope or polarising attachment.

Analytical procedures

Reduced to its bare essentials, the general method of analysis is to measure the degree of absorption of the test material at the selected wavelength or wavelengths, and to deduce the concentration of the component of interest from a working curve relating the concentration and amount of absorption prepared under conditions similar to those used in the measurement of the unknown. These conditions should be chosen so that the working curve is as nearly linear as possible. With the single-beam spectrometer, the method employed is what is often known as the 'cell in, cell out' procedure, in which the reading of the output meter is noted, first with one of a pair of cells containing the test substance in the path of the beam, and then with a matched reference cell in position without the test material. With a double-beam instrument the comparison may be made directly with one cell in each beam. The use of a differential method with the double-beam instrument is often advantageous when the unknown concentration is small or the absorptive power is low, as the conditions can be arranged to give a relatively large full-scale deflection of the output meter for a given concentration. Other procedures have been devised to meet special circumstances. Liquids and solids are usually examined in solution in solvents having low absorptive power at the selected wavelength, and gases and vapours at suitably-adjusted known pressures.

When there is only one infra-red reactive constituent present in the mixture, or a unique wavelength can be found at which a particular component of a mixture absorbs infra-red radiation and the others do not, the calculation is straightforward. It becomes more tedious and complicated, however, when one is dealing with a complex mixture of substances such as might be present in the product of a process reaction, when some or all the constituents of the mixture may be capable of absorbing infra-red energy at each of the different wavelengths selected for the various components, especially when the relation between the degree of absorption and concentration is not linear. It then becomes necessary to measure the absorbance of the test mixture at as many key wavelengths as there are

constituents to be measured, each wavelength being chosen to represent a particular component with as little interference from the others as possible, and to construct a series of simultaneous equations in which the total absorbance is equated at each wavelength to the sum of the absorbances of the individual components. The values of the individual absorbances may then be extracted by solution of these equations, and from them the values of the concentrations, making use of Beer's law or a working curve. When there are numerous components it may be necessary to use a computing device and proceed by the method of successive approximations.

Information on this procedure may be found in an excellent article by Brattain *et al.*[2] dealing with the analysis of hydrocarbon mixtures. J. C. Hawkes[3] has discussed infra-red analytical techniques in a recent article on their use in general chemicals manufacture.

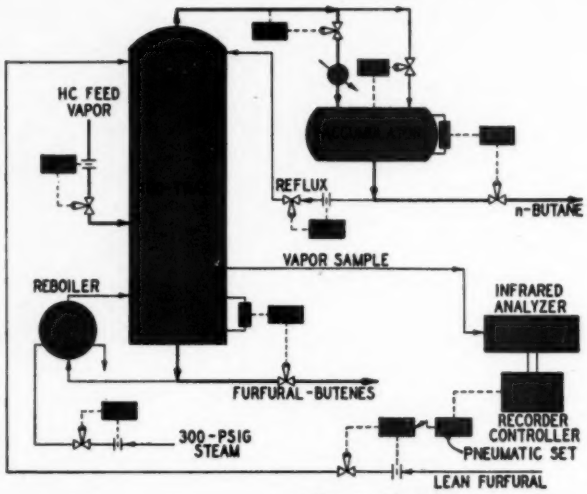
Commercial spectrophotometers

For many years prominent in the design and production of commercial spectrometers, Adam Hilger (now the Hilger division of Hilger & Watts Ltd.) make a double-beam prism spectrophotometer for recording percentage transmission, having automatic control of slit width, and Schwartz thermocouple-galvanometer measuring system with photo-electric amplification. This firm also makes a non-recording industrial model for single-beam operation.

Unicam Instruments (Cambridge) Ltd. produce a double-beam drum-recording spectrophotometer of more advanced design having several unique or unusual features, including provision for double-pass operation or use as a double monochromator, an evacuable chamber for the light path, and a Golay detector. This instrument operates on the null-balance principle and has automatically adjustable slits coupled with the wavelength drive. The SA4 single-beam instrument marketed by Grubb-Parsons of Newcastle-on-Tyne can be converted to double-beam operation by the use of a separate double-beam radiation unit, in which means are provided for switching alternately two beams of radiation through the absorption cell. It uses chopped radiation and operates on the null-balance principle. The most recent GS2 and GS3 models produced by this firm have gratings instead of prisms, and can scan a spectrum over the wavelength range in 9 min.

The Mervyn-NPL spectrometer is of unusual interest because of the use of the new, inexpensive Merton-NPL replica diffraction gratings, lead sulphide photo-conductive cell detector and high rate of interruption of the radiant beam (800 c/s.) made possible by the rapid response of the detector. It is claimed that the remarkably high resolving power of only one wave number can be obtained at a wavelength of 1 μ. The use of this instrument is restricted to the 1 to 4 μ wavelength range by the use of the photoconductive cell, but its high resolving power enables compounds to be differentiated by means of valuable absorption bands in this range which are otherwise difficult to distinguish in a commercial instrument.

In the United States the Beckman Instrument Co. pioneered the production of the modern type of industrial infra-red spectrometer. Apart from single- and double-beam instruments of more or less conventional design, it makes a single-beam spectro-



[*Courtesy: Chemical Engineering Progress*

Complete pneumatic control system, utilising the on-stream infra-red analyser-recorder-controller of the Phillips Petroleum Co. installation. (Berger and Campbell.[10])

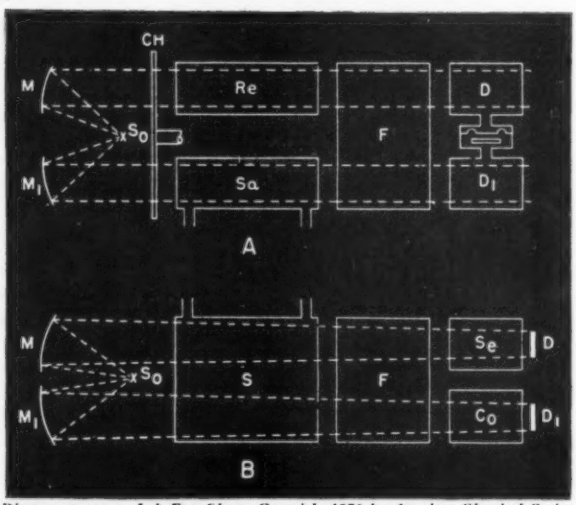


Diagram courtesy: Ind. Eng. Chem. Copyright 1956 by American Chemical Society and reprinted by permission

Two schematic diagrams (Savitsky and Bresky[7]) of non-dispersive instruments: (*a*) Luft-type analyser, in which the detector is a two-sided condenser into which has been placed some of the gas of interest; and (*b*) class negative filter-type instrument, the detectors being bolometers or thermopiles.

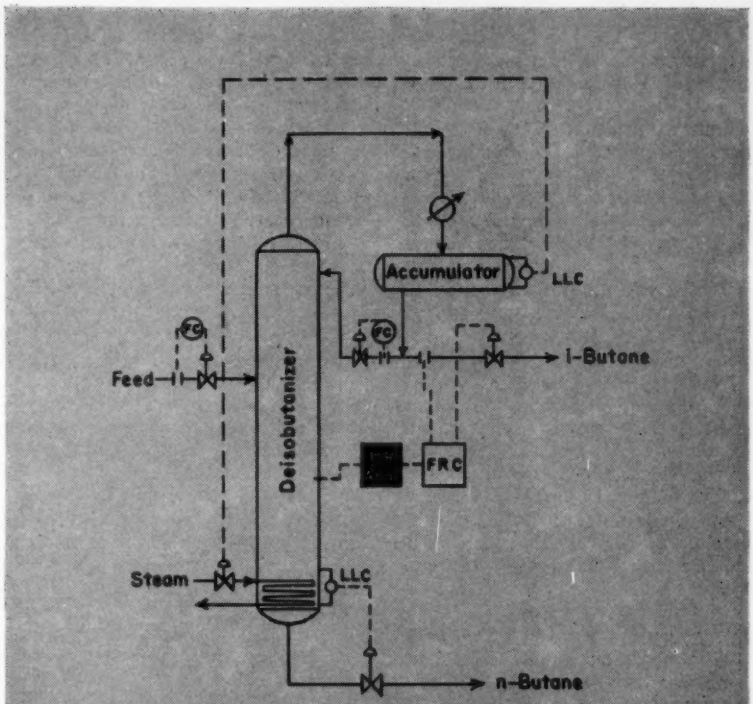
meter arranged for double-beam performance in which a tape recording performs the function of the reference beam. The Perkin-Elmer Corp. makes a number of models for different purposes and specialises in the unit system of construction for ease of interchange and adaptability. Baird Associates Corp., of Cambridge, Mass., make a drum recorder generally similar to the one made by Unicam Instruments. A spectrometer made by the Farrand Optical Co., of New York, can be used in the visible and ultra-violet regions as well as the infra-red, as can one of the models made by the Beckman Co.

Non-dispersion continuous analysers

The process supervisor will probably be more interested in the continuous type of infra-red absorption analyser designed for use on the plant. It is usually a non-dispersion instrument in which sensitivity and selectivity are secured by the differential absorption in a double-beam system. Instruments of this type are usually classified as positive or negative filter analysers according to the means used for sensitising them to the component of interest and reducing interference by other infra-red absorbers present in the mixture.

Instruments of the ' positive ' type have a selective detector reacting to radiation in the emergent beam of the characteristic wavelength of the component of the test mixture being measured. In the Luft-type analyser to which most of these instruments conform, being so named after the designer of the original instrument designed on this principle,[4] the detector takes the form of a condenser microphone, having two gas cells, one for each beam, separated by a sensitive diaphragm. These cells are filled with pure gas of the same kind as the absorber in the test gas, either alone or mixed with inert diluent gas. As the intensity of the residual infra-red energy in the beam after passing through the sample cell is less than that of the beam passing through the reference cell, a pressure difference is set up between the two sides of the diaphragm separating the detector cells and is converted into an electric signal. Analysers of this type usually employ means for interrupting the two beams in phase at a controlled frequency in conjunction with a tuned amplifier.

Negative-filter-type analysers usually have non-selective black-body detectors absorbing a large fraction of the radiation in the emergent beams. In these analysers both radiant beams pass through a common sample cell containing the test gas. The instrument is sensitised to the component of interest by interposing between the sample cell and the detector in one of the paths another cell containing some of the same component; a given change of concentration in the sample cell thus produces a proportionately greater change in energy reaching one detector than in that reaching the other. The difference is recorded as a measure of concentration. Compensation for the effect of interfering components of the test mixture may be obtained in some degree by placing a compensating cell containing these components in the other beam, and by placing a common filter containing interfering components in both paths. As an example of the application of this principle, a reasonably satisfactory solution to the very difficult problem of measuring ethylene in admixture with methane and ethane, in which the absorption by the ethane interferes severely with that of the ethylene, was obtained by placing ethane in the compensating cell, and methane in the interference cell.



[Courtesy: Petroleum Processing

Infra-red analyser in control of a butane splitter by a cascade arrangement. (D. P. Thornton.[5])

Each of these two types of analyser has its peculiar advantages. The positive-type analyser gives a much greater signal change for a given concentration change, because the proportion of useful absorbed energy directly related to the absorption by the component of interest in the sample is greater. On the other hand, although the inherent sensitivity of the negative-filter-type analyser is lower, the principle on which it operates lends itself better to reduction of interference by components with overlapping absorption bands. Reduction of interference by filtration may be employed in the positive-type analyser, but to a more limited extent.

Here one might ask why not combine the essential features of these two kinds of continuous analyser and thus obtain the maximum sensitivity, stability and discriminating power ? This combination has, in fact, been effected in the *Tri-Non* analyser manufactured by the Perkin-Elmer Corp.,[5, 6] and in other analysers. In this instrument a separate ' nulling ' path has in effect been added to a negative-filter-type analyser, and is chopped in phase with the sensitiser beam. This

arrangement allows the use of optical feedback from the detector *via* the amplifier, to drive an attenuator in the nulling path to produce a radiation null at the detector. The position of the attenuator measures the concentration of the constituent of the mixture being tested. This type of analyser has been used to handle difficult mixtures where much interference occurs. As it is a more expensive instrument, one would not use it for those mixtures which can satisfactorily be analysed by the simpler instruments.

Continuous dispersion-type analysers

Whilst the dispersion analyser has a limited resolution determined by the slit width and the optics of the system, as compared with the infinite resolution offered by the non-dispersion analyser, it has advantages in other respects. It is potentially more versatile inasmuch as it offers a considerable range of wavelengths from which to choose, so that it could be quickly adapted to the solution of different problems; it also has the attractive feature that its performance can be predicted from the absorption spectra of mixtures obtained with a single-beam spectrometer.

As far as the writer knows, there is only one continuous dispersion-type analyser at present on the market, the Perkin-Elmer Corp.'s model 93 *Bichromator*.[7] Possibly the severity of conditions of use in the plant has hampered progress in this direction. In this instrument, compensation for some spectral overlap is obtained by using a sample wavelength and a reference wavelength, achieved by the use of two Littrow mirrors with an otherwise common optical system. Beckman Instruments Inc. has discontinued production of its model 176 dispersion analyser, and hopes that the Mervyn-NPL spectrometer could be used for continuous plant analysis do not appear to have been realised.

Commercial analysers

Although applications of the continuous analyser have been known since 1938, it is only during the last seven years or so that reliable instruments have become available. Some of the latest models are remarkably sensitive. Britain has fallen behind current practice elsewhere, but the recent introduction of new instruments is an indication that attempts are being made to close the gap.

The Grubb-Parsons I.R.G.A. continuous analyser is a direct-deflection instrument employing interrupted radiation and synchronous rectification of the a.c. signal. A sensitivity equivalent to a gas concentration of 0.02 to 0.25% at full-scale deflection may be obtained, depending upon the gas being measured. An improved null-balance analyser designed for greater stability and safety is now being developed. The Infra-Red Development Co., Welwyn Garden City, makes two gas analysers, one with a Luft-type detector operating on the null-balance principle for use under conditions where special stability is needed, and the other a direct deflection instrument which can be moved from place to place, and is more suitable for spot tests. This firm recently introduced a high-sensitivity analyser capable of rapid response, of interest for automatic control purposes.

American instruments

A greater variety of analysers is available in the United States. These include the *Lira* analyser of the Mines Safety Appliances Co., the Perkin-Elmer Corp.'s *Tri-Non* analyser, already mentioned, and the Liston-Becker Co.'s continuous gas analyser. These instruments all have Luft-type detectors, the first two being null-balance analysers. The Consolidated-Phillips analyser and the one made by Baird Associates, of Cambridge, Mass., are negative-filter analysers employing bolometers. The advanced design of the former instrument is worthy of note, including provision for automatic standardisation and zero adjustment, adjustable full-scale analytical span, automatic cycling for the analysis of five process streams, and remote indication.[8] The new model 21 Liston-Becker has a sample cell operating at a gas pressure of 500 p.s.i., and is claimed to give 90% response to concentration change in 0.5 sec. There are said to be more of this make of analyser in use in ammonia plants than any other.

A continuous analyser installation represents a considerable capital investment, as the more elaborate null-balance type of instrument costs something like £1,000. Direct deflection analysers cost £500 to £600.

Uses of continuous plant analysers

Although in theory the concentration of almost any substance having a heterogeneous molecule capable of absorbing infra-red radiation may be measured in a plant analyser provided that it can be made to flow through the absorption cell at a suitable rate without the use of excessive pressure, the use of the infra-red technique is confined chiefly to the analysis of mixtures of simple gases. It has been applied in a limited number of instances to the analysis of liquid streams, but in general they are difficult to handle because of the excessive resistance of a thin cell to flow at a rate sufficiently high to be useful.

A few of the various kinds of gas mixtures which are being successfully analysed may be mentioned. Probably the most notable ones are the mixtures of hydrocarbon gases and vapours, as there is often no practicable alternative. Here the chief problem to be overcome in infra-red absorption analysis is the interference caused by the overlapping absorption bands of the various components of the mixture. Difficult problems of this nature which have been successfully overcome are the determination of ethylene in a mixture of ethane and methane, and of isobutane in butane where isopentane in quite small concentrations can cause serious interference. Other gas mixtures which are being handled are acetylene in HCN, HCN in acetylene, methane in a 14-component mixture, monovinyl acetylene in an 11-component mixture, carbon dioxide and carbon monoxide in air in various concentrations, and in mixtures with water vapour and hydrogen, and sulphide dioxide-air mixtures.

The infra-red absorption method cannot be applied to the analysis of mixtures of gases having homopolar molecules, as they are not capable of absorbing infra-red radiation. Water present in large concentrations, say up to 10 to 20%, is a considerable nuisance and, if the circumstances permit, it may then be necessary to resort to ultra-violet absorption instead of infra-red. For certain ammonia synthesis plant applications, infra-red analysers are the only direct gas analysers available[9] and an increasing number of these instruments are being used. In these plants they are used for indicating the efficiency of carbon dioxide scrubbing and of trace removal of carbon monoxide by copper liquor, the concentration ranges being 0 to 1% for carbon dioxide and 0 to 30 p.p.m. for each gas, depending upon the conditions. Examples given by Hausdorff[6] are the continuous determination of methane in a plant manufacturing acetylene in an acrylonitrile plant and the determination of acetylene at various stages of the process.

Examples in the more difficult field of liquid analysis are the determina-

tion of water in alcohols and ketones, the analysis of hydrocarbon mixtures and the determination of benzene.

Application to automatic control

Infra-red absorption analysis has great possibilities in the field of automatic process control; indeed, the opinion has been expressed that infra-red analysers may be the first major class of control device to enable the chemical process industries to be made completely automatic. Much of the equipment and technical knowledge necessary for the automation of both new and old processes is already available, but there is need for careful study of the dynamic response characteristics of systems employing this form of control. It will also be necessary to make further improvements in the accuracy, stability and speed of response of instruments before there can be a widespread development, as close control is necessary to justify the cost.

The meagre amount of published information which has appeared on this subject is concerned with the more recently developed chemical processes. As is not surprising in view of their activity in developing the infra-red analyser, it is the petroleum companies who have been most interested in these applications. The Phillips Petroleum Co. has shown much enterprise and initiative in this direction. It has employed infra-red analysis control in cascade with more conventional methods of control of secondary variables as an over-ride to curb excessive fluctuation of operating conditions and to keep them within prescribed limits. Two applications of a closely similar nature may be noted.

One of these applications is the control of the proportion of isobutane in the overheads from a fractionating column in which isobutane product is being separated from *n*-butane in a natural gasoline plant.[8] On control by the conventional means—a flow controller for the reflux stream to the column, a controller on the overhead product regulating the re-boiler steam rate and a level controller on the bottom stream from the re-boiler—is superimposed infra-red analysis control of the *n*-butane bottoms, operating by resetting the set point of the flow controller of the overhead product stream.

The Phillips Petroleum Co. has also applied infra-red analysis to the control of a large column used for the separation of 2-butenes from *n*-butane in a furfural distillation unit, in which the furfural is used as selective solvent for the butenes.[10] The analyser takes its sample from the vapour space above the 24th tray from the bottom of the column, and re-sets the rate of furfural feed to keep it within a prescribed range, thus acting as an over-ride. By this means the concentration of butenes in the *n*-butane overhead is prevented from rising above 1 to 2%, and the concentration of butenes in the furfural is maintained at 20 to 25%.

Other interesting examples of the application of infra-red analysis for the automatic control of recently developed processes which have been described in the patent literature are the control of the rate of addition of catalyst promoter for maintaining optimum conversion efficiency in the production of 2, 3-dimethyl butane by alkylation of isobutane (J. L. Groebe, U.S. Pat. 2,518,307), and the control of the elimination of iron and cobalt carbonyls formed as impurities during the production of aldehydes and other compounds in a carbonylation reaction (C. S. Starr, U.S. Pat. 2,636,904). In applications of this kind, good control depends to a large extent upon the selection of the best point from which to take the sample for analysis, preferably the one where the concentration gradient of the components which it is desired to separate is as great as possible. For some applications there is, of course, no choice.

It is interesting to note the application of automatic control by infra-red absorption in two well-established processes, the synthesis of ammonia and the manufacture of nitric acid by the oxidation of ammonia.[9] In one plant it measures the concentration of unreformed methane in a mixture of synthesis gases containing carbon monoxide, carbon dioxide, hydrogen and nitrogen leaving the natural-gas reformer, and controls the reaction rate to the reformer. In the nitric acid plant it was proposed to use control by infra-red analysis of the products from the oxidation catalyst instead of control by temperature of the hot gases, with a view to producing a more uniform blend of the ammonia and air mixture fed to the burner.

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A New Use for Bark

At present largely a waste product of the lumber, pulp and paper industries, bark will become a material with a vast potential market if investigations recently undertaken by the Armour Research Foundation of the Illinois Institute of Technology, in co-operation with Canadian Forest Products Ltd., lead to commercial development. Under the direction of Dr. C. Roland McCully, its scientific adviser, the A.R.F. chemistry and chemical engineering research department have developed a method whereby bark can be converted into a first-class soil builder.

Although some of the tens of millions of tons of bark made available annually are partially dried and used as fuel, most of it is disposed of, often at very considerable cost. When perfected, this development will enable even those companies that do not contemplate production of a soil-builder material themselves to dispose of their bark wastes at a profit.

Involved in the process of producing a soil builder from waste bark is the grinding of the bark and the condensing of the tannin by the addition of formaldehyde followed by acidification with hydrochloric or sulphuric acid. The mixture is then heated for a brief period to complete the condensation process. Water and other excess chemicals are removed and the material then washed and dried.

The soil builder, as such, does not fertilise the soil, but rather increases its tilth, eliminating clods or hard lumps and enabling the plants to feed better and grow. Whereas peat moss, which is used extensively for this purpose, costs in America about $4.60 to treat 100 sq. ft. of soil 6 in. deep, the indications are that it would cost about 40 cents to produce enough bark soil builder to treat the same amount of land. The bark soil builder was tested in the field by the University of British Columbia with barley and beets with excellent results that confirmed indoor tests conducted by the Foundation. In both tests the bark soil builder was found to be more effective in promoting growth and improving the soil than either peat moss or commercial soil conditioners.

Recent Developments in

CRYSTALLISATION

Crystal growth and structure; ammonium sulphate manufacture; new and improved crystallising equipment; solubility studies, etc.

FOLLOWING the pattern of previous reviews, the last of which appeared in CHEMICAL & PROCESS ENGINEERING, 1956, **37** (7), 221-224, this article reviews the latest advances in this field, as follows.

Crystal growth

Fehlner[17] has prepared a survey, with 44 references, of laboratory methods for growing crystals. Sanchez[51] has described how crystallisation in solutions may be induced with the aid of low-frequency vibrations transmitted to the fluid by a submerged membrane or piezoelectric disc connected to an electromagnetic vibrator. A modified account of the theory of crystal growth in undercooled pure liquids, with comparisons between observed and calculated crystallisation velocities for water, glycerol, salol, Sn and P has been presented by Hillig and Turnbull.[20]

Bauer,[5] using the results obtained from an investigation by electron diffraction and the electron microscope of thin layers of fluorides, deposited by evaporation on different supports, has developed a model of the growth mechanism which can explain the phenomena of orientation.

Chatterji and Mathur[10] have studied the viscosity and linear velocity of crystallisation of resorcinol in aqueous and non-aqueous solutions at various temperatures. The effect of organic impurities was also investigated.

Schlipf[12] has considered the kinetics of layer growth, the growth mechanism of dendrites and the calculation of the diffusion field of cubic crystals growing from solution. Kossel,[37] considering crystal growth as a molecular phenomenon, has described several growth processes, the primary one being the sedimentation of new particles on the crystal.

Komarova and Figurovskii[33] have measured the rate of crystallisation of a variety of inorganic salts from their solutions initially having various degrees of relative supersaturation. Data on the rate of crystallisation and the total amount of crystals formed have been tabulated and presented in graphical form.

Pozdnyakov[49] has studied the growth of crystals of $Li_2SO_4.H_2O$ and gives details of the crystals obtained from acid, neutral and weakly basic solutions.

Danilov and Malkin[14] have attempted to verify experimentally the theories of crystal growth by measuring the linear growth of the crystal boundary for phenyl salicylate in the region of slight supercooling. Their experimental curves coincide with theoretical curves.

Seeger[53] has assumed an idealised system and attacked mathematically the diffusion problems associated with the growth of crystals from dilute solutions; in particular the three-dimensional growth of regular polyhedra is treated through a heat-conduction analogy, and approximate solutions for a cube, tetrahedron, octahedron, dodecahedron and icosahedron are presented.

Rais[50] has investigated the existence of a transition layer in mechanically twinned calcite crystals using optical methods and concludes that there is no transition layer in such crystals.

Lemmlein and Dukova[39] have studied the formation of spiral dislocations during the growth of crystals of naphthalene and *p*-toluidine sublimed from the vapour phase. The growth rate of crystals, as a function of under-cooling, has been investigated by Jantsch[26] with special reference to crystals of salol grown from the melt.

Karyakin and Kainarskii[30] have discussed the crystallisation of silica from the gas phase. The silica appeared in the form of a dense precipitate of coarse oolites on the surface of a lightweight SiO_2 brick prepared by incorporating 30% coke and firing at 1,410°.

Bliznakov[6] has made a theoretical study of the effect of adsorbed impurities on the growth of a crystal boundary. The results are compared with experimental data.

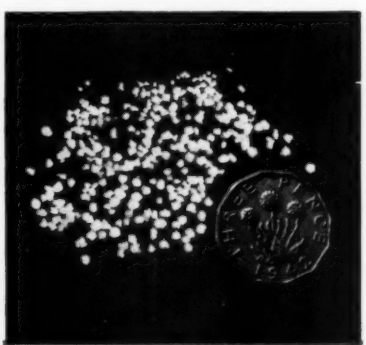
Knacke and Stranski[31] have made a theoretical study of the effect of the adsorption of foreign substances on the specific free surface energy of crystals. In the case of a simple cubic crystal lattice and a hypothetical gas mol. with three adsorption valences they show that the lowering of the free surface energy may be sufficient to bring about a new crystal habit.

Crystal structure

Hirokawa[21] has described the crystal structure of a new modification of L glutamic acid. The unit cell bears a close relation in dimensions to the other modification reported by Bernal.

Votava[61] has obtained direct evidence of the presence of screw dislocations at grain boundaries of NaCl crystals from an examination of characteristic edge structures which appeared after the crystals had been heated for four days at 780°. Dunitz, Orgel and Rich[16] have carried out an *x*-ray analysis of the crystal structure of ferrocene. Gould[19] has determined the triclinic cell dimensions of tropylium chloride, prepared from anhydrous acetonitrile. Morris[45] has furnished data on the lattice energies of the alkali halides.

Bode and Teufer[8] have investigated the crystal structure of hexafluophosphoric acid. The acid $HPF_6.6H_2O$ is cubic, with the water mols. forming



Crystals of KCl illustrating the uniformity of product obtained with 'Krystal' equipment.

In transit here is a 'Krystal' ammonium sulphate evaporator designed by the Power-Gas Corporation Ltd. and fabricated under their supervision in France.

cubo-octahedral cages of 24 oxygen atoms in the centres of which the P atoms of the PF_6 groups are located.

Siegel[55] has determined the unit-cell dimensions of the trigonal modification of U_3O_8. This modification is obtained when the orthorhombic form is heated to about 400°.

Lundgren[42] has published detailed data on the crystal structure of $CeOSO_4.H_2O$ prepared by sealing an acid solution of $Ce(SO_4)_2$ in a glass tube, heating to 200° and leaving for a week, after which time rod-shaped yellow crystals are obtained.

Tanito, Saito and Kuroya[56] have determined the unit cell dimensions, by *x*-ray examination, of crystals of chlorodinitrotriamine cobalt produced by the slow evaporation of a saturated aqueous solution containing a small amount of AcOH at 20°. Ievins and Ozols[25] have carried out a precision determination of the lattice constants of monoclinic crystals of $KClO_3$. Mathematical formulae are derived.

Dohlen and Carpenter[15] have determined the crystal structure of isocyanic acid by *x*-ray methods at about −125°. The molecular dimensions are similar to those in the vapour state and, although a second crystalline form is stable below about −100°, the *x*-ray results apply to the high-temperature form which readily supercools.

Houten, Vos and Wiegers[23] have determined the crystal structure of P_4S_3 from a three-dimensional Patterson synthesis followed by Fourier syntheses of the three projections. Co-ordinates of the atoms and intramolecular distances and angles are given. The structure agrees with one determined independently.

Yamashita and Kurosawa[63] have developed the theory of oxide crystals for MgO, CaO and SrO which are assumed to be in the totally ionic state. The formation energy of the Schottky defect was computed according to the method of Mott and Littleton.

Cruickshank[13] has described a detailed refinement of the crystal and molecular structure of anthracene, based on *x*-ray crystallographic data of Mathieson *et al.* The calculations needed were performed on the Manchester University electronic computor.

Kaishev[28] has investigated the thermodynamics of the growth of new lattice layers. Calculations were carried out for the reversible isothermal formation of two-dimensional complexes on different crystal boundaries in relation to the supersaturation of the mother liquor.

The lattice energy of ionic crystals is the subject of a review, with 25 references, by Kapustinskii.[29] Ubbelohde[59] has written a review, with 50 references, on crystallography and the phase rule.

Ammonium sulphate

Otto[48] has written an account of ammonium sulphate manufacture at the Berlin Gas Mariendorf gas coke-oven plant. The precautions taken to minimise corrosion of the building and equipment and a screen analysis of the product which contains 0.026% free acidity are given.

Koppers Co.[36] have patented a method for the recovery of ammonium sulphate from a dilute solution of sulphuric acid and coke-oven gas containing NH_3. A combined crystalliser and absorber is described.

Lewis[40] has described production techniques in three types of plants—direct, semi-direct and indirect—concerned with sulphate of ammonia production on Tyneside. In the indirect system the ammonia is recovered in a solution of its salts; in the direct and semi-direct systems all or part of the ammonia is recovered as the sulphate.

Ashley and Sanborn[3] have patented a process involving evaporation and crystallisation whereby substantially pure sodium sulphate and ammonium sulphate are recovered from dilute solutions. Particular reference is made to the treatment of waste from the manufacture of SiO_2-Al_2O_3 catalysts.

Hutcheson, Phillips and Bennett, Sons & Shears Ltd.[24] have described in a patent a method of improving ammonium sulphate evaporators to give crystals of a uniform medium size. The evaporator incorporates a comparatively large-diameter, insulated downcomer pipe.

A method preventing the caking tendency of ammonium sulphate by adding traces of water-soluble cadmium salts or dithionate has been patented.[34]

Apparatus and industrial practice

The chemical removal of Ca oxalate scale formed in sugar factory evaporators has been described by Carolan.[9] The recommended method involves boiling for several hours with 2 to 5% Na_2CO_3 followed by treatment with weak or inhibited HCl.

Mel'nik[44] has discussed industrial methods of salt production, assuming that the salts can be placed in one of two groups according to their solubility changes with temperature. Examples are given.

The separation of KCl from sylvinite ore as carried out in the potash division of the Duval Sulphur & Potash Co. has been described by Atwood and Bourne.[4] The process is essentially refining by froth flotation using an improved reagent scheme followed by crystallisation of the KCl in a *Krystal* vacuum crystalliser.

Aldebert[1] has described apparatus constructed so that heat of crystallisation can be removed by evaporation of a volatile liquid. The equipment is suitable for crystallisation from solution or a melt. Waji and Makuta[62]

have obtained a Japanese patent for crystallising apparatus employing constant-temperature baths, and Aoyama[2] has patented apparatus for two-stage vacuum crystallisation.

A new circulation apparatus for determining the effect of impurities on crystal growth has been described by Bliznakov and Kirkova.[7] Special reference is made to the effect of Na_2SO_4 impurity on the growth of $NaClO_3$. The effect of methylene blue on $Pb(NO_3)_2$ was also studied.

Timkin[57] has discussed improvements in industrial salt crystallisation and advocates the use of mechanically stirred crystallisers.

Jassawalla[27] has described a method of preparing high-purity salt from crude salt of 98% purity made by solar evaporation. The process involves partially dissolving the salt and centrifuging to lower the Mg content, then completely dissolving the salt and precipitating the remaining Ca and Mg by adding lime and soda ash, and finally evaporating.

Ushatinskii, Golub and Bukshtein[60] have described how incrustation formation during evaporation of sodium sulphate solutions can be prevented by priming the solutions with suspended incrustation-forming crystals. Results from a demonstration unit are given.

Some items of general interest regarding the urea-adduct process are presented.[11]

Miscellaneous

Solubility polytherms for the system H_3BO_3-$MgSO_4$-H_2O have been determined by Manole-Bezhan and Sokolovskii[43] over the range 10 to 90°. The composition of the solid phases were determined and the 65° isotherm which has industrial significance is given.

Sheveleva[54] has studied the system $(NH_4)_2Cr_2O_7$—$(NH_4)_2SO_4$—H_2O and determined isotherms at 5°, 25° and 50°. The only solid phases observed were $(NH_4)_2Cr_2O_7$ and $(NH_4)_2SO_4$.

Nallet and Rene[46] have investigated the equilibrium solubilities of the chlorides and chlorates of sodium and potassium in water, at various temperatures ranging from –19.2 to 100°.

Hostalek[22] has determined analytically the phase equilibrium in the system H_2O-Na_2CO_3-NaOH in the temperature range 0 to 120°. The results have been tabulated and compared with existing data in the literature. In the range 35 to 120° the composition of saturated solutions was found to be practically independent of temperature.

Konopkina[35] has investigated the equilibrium of solubility in the system $CaCr_2O_7$-$K_2Cr_2O_7$-H_2O at 0°, 25° and 50°. Compound formations and solid solutions were not detected.

Golub and Kilimnik[18] have determined the solubility of $BaCl_2$ in solutions of $CaCl_2$ for concentrations of $CaCl_2$ ranging from 3 to 33%. At 33% $CaCl_2$ the solubility of $BaCl_2$ becomes negligible. The effect of temperature is more pronounced in the less-concentrated solutions, becoming slight at 15% $CaCl_2$ and negligible at 33% $CaCl_2$. No evidence of complex formations was found.

A new procedure, called crystallisation pycnometry, and its application to the measurement of the volume changes which occur on melting crystals of KCl, KBr, NaF and Na_3AlF_6, have been described by Landon and Ubbelohde.[38]

Chivate and Shah[12] have described a method of separating *m*-cresol and *p*-cresol by a process of extractive crystallisation using AcOH as the solvent. Solid-liquid equilibria were determined. Kofler[32] has studied the behaviour of mixed crystals in fusion and crystallisation. Non-uniform composition of solid solutions is equalised partially by diffusion and also by structural rearrangements.

The diffusion of bivalent impurity ions in crystals of the NaCl type has been examined theoretically by Lidiard.[41]

Nikitinskaya and Murin[47] have described an experimental study of the thermal diffusion of sodium ion in crystals of sodium chloride. Measured values appear to indicate that the defects are of the Frenkel type.

Tsinzerling[58] has discussed the phenomenon of 'memory' in quartz crystals. Naturally occurring twinned quartz crystals when converted to single crystals by torsion often revert to the twinned state. Such crystals are generally found to contain a large amount of impurities.

Acknowledgment

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(*Concluded on page* 344)

Principles of Refining LUBRICATING OIL

(Part 2)

By A. Doll-Steinberg, B.A.

In the first part of this article, which appeared in our July issue, the author discussed the various lubes and their properties, the selection of crude oils and refining methods, and de-asphalting. He now goes on to discuss the solvent extraction method of refining, comparing the various solvents and methods available, and also deals with the problems of dewaxing, ending with some notes on economic factors.

IN solvent extraction the difference in the solubilities of the paraffinics and the naphthenics in various solvents is utilised to achieve separation. The aim of refining is to produce the maximum yield of product with the desired properties for a given cost. With this end in view, the ideal solvent for a given crude should have the following properties:

(*a*) A highly selective solvent action, *i.e.* the two phases obtained on addition of solvent to the oil should show a large difference in some specified property, *e.g.* in their V.I.s.

(*b*) It should also have a high solvent power, *i.e.* the extracted fractions of the oil should be highly soluble in order to minimise the solvent ratio necessary for the efficient extraction. As crude oils consist of a spectrum of compounds, these two ideal properties are obviously to some extent mutually exclusive.

(*c*) There must be a marked difference in the densities of solvent and oil to ensure easy separation of the resultant two layers.

(*d*) It should be available and cheap to minimise the cost of unavoidable losses.

(*e*) For easy recovery, it should have a boiling point much lower than the oil fractions and also a low latent heat.

(*f*) It should be stable, easy to handle and non-toxic and non-corrosive.

(*g*) It should be applicable at convenient temperatures and pressures.

Ferris *et al.*[1] investigated 110 solvents for use in lubricating oil extraction. No solvent had all of these properties and in practice a compromise is reached. The most used single solvents are furfural, phenol and *Chlorex*. Sulphur dioxide and intro-benzene are also used to some extent. SO_2 is extremely selective, but has very low solvent power.

Selection of a solvent

It is possible to compare the extractive properties of solvents for a given crude by plotting their phase-equilibrium relationships on a ternary diagram.[2] This method becomes involved when comparisons at different temperatures have to be made. Kalichevsky[3] provides a more satisfactory method of making such comparisons. He defines the quantities solvent power (Z), selectivity (X) and refining power (R) in the following manner.

For an additive property (*e.g.* S.G., V.G.C. etc.), P is the value of the property for the raffinate, P' is the value for the extract and P_o for the charge. Then, since the property obeys the lever rule, fractional loss of charge (to extract), L, is given by:

$$L = \frac{P_o - P}{P' - P}$$

and yield $Y = \dfrac{P' - P_o}{P' - P}$

Then the selectivity X is defined by:

$$X = P' - P = \frac{P' - P_o}{Y} = \frac{P_o - P}{L}$$

The solvent power Z is defined as:

$$Z = \frac{L}{S}$$

where S = solvent ratio. The refining power R =

$$\frac{P_o - P}{S} = \frac{L}{S} \times \frac{P_o - P}{L} = Z \times X$$

X, Z and R are functions of the solvent and oil, the solvent ratio and the temperature.

The refining power is the most significant quantity for a solvent, being a measure of the smallness of the solvent ratio needed to effect a given improvement in the selected property. A suitable solvent will have high numerical values for X, Z and R occurring at the same conditions of solvent ratio and temperature.

The merit of these three quantities as defined is that, when they are plotted logarithmically against solvent ratio at constant temperatures, straight lines are obtained, thus making possible the direct comparison of various solvents.

Kalichevsky gives plots of X, Z and R for the three most commonly used solvents extracting a medium viscosity mid-continent oil. These graphs are not of general application as X, Z and R vary with the stock, but they are indicative of the characteristics of the solvents relative to one another.

By inspection of these graphs (Fig. 5) we see that:

(*a*) Over the temperature ranges considered, the three solvents have values of X, Z and R of the same order. The variations with temperature differ considerably, however, and this is best brought out by R.

(*b*) The dependence of R on temperature shows considerable variation from solvent to solvent. Thus temperature has a large effect on R for furfural and *Chlorex*, but only a minor effect on R for phenol, especially at the lower solvent ratios such as are used in practice.

Effect of changing temperature of solvent

Now the properties and yield of raffinate can be maintained by adjusting the two variables, temperature and solvent ratio. In practice, large variations of solvent ratio are avoided, as this is at a minimum and a change will thus reduce the capacity of the plant. It is therefore important to be able to change the properties of a solvent by changing the temperature. With pure phenol this is seen to be impossible. Furfural, on the other hand, is more flexible to treat varying stocks, and improvements can be achieved by using a temperature gradient. However, phenol is a competitive solvent, because the injection of water into it modifies its properties in the same way as a change of temperature does with furfural and *Chlorex*. Thus internal reflux is obtained in the furfural process by cooling the extract end and in the phenol process by water injection at the extract end.

Comparison of properties of furfural, phenol and 'Chlorex'

We may compare the properties of these solvents which determine the ease with which they can be reclaimed:

	Boiling point, °C.	*Specific heat, B.Th.U./lb.°F.*	*Latent heat, B.Th.U./lb.*	*Melting point, °F.*
Furfural	162	0.416	193.5	−34
Phenol	183	0.56	206	105.6
Chlorex	178	0.369	115.4	−61

On this basis and considering the high values of *X*, *Z* and *R* for *Chlorex* (see Fig. 5), this solvent should be one of the best extractive agents. The main factor decreasing the value of this solvent is that it is not very stable under plant conditions and gives rise to corrosive HCl.

The high melting point of phenol is lowered by the water which is always used in this process, but even so, this is one of the main disadvantages of phenol as a lube-oil solvent. Another disadvantage of this solvent is its rather low specific gravity.

The major drawback of furfural is its instability. This leads both to losses of this fairly expensive solvent and also to corrosion. With care, this disadvantage can be made negligible.

The recovery system for furfural is somewhat less complicated than for phenol. Water is introduced during reclamation in the steam stripping columns, and its elimination involves recycle of solvent-water streams in both cases, owing to the fact that both solvents form azeotropes with water. However, the furfural water azeotrope has a composition (35% furfural) widely different from the compositions of the two layers formed at lower temperatures (93% and 9% furfural at 30°C.). The corresponding phenol-water mixtures show much smaller composition differences and thus more recycling is necessary. A recent improvement in phenol recovery, involving the vaporisation of the phenol-water streams and contacting them with the incoming charge stock, is described by Nelson.[4]

SO_2 as a solvent

The SO_2 process is generally applied only to naphthenic base oils, from which very low V.I. constituents must be removed, but practically none of intermediate V.I., SO_2 having an extremely selective action. Owing to its very low solvent power, its successful application to a paraffinic crude would require the use of large solvent ratios. For such conditions the addition of benzene improves the solvent power to any desired extent, with, of course, consequent loss of selectivity. This can, however, be tolerated with a paraffinic crude containing, as it does, a high proportion of high V.I. constituents.

'Duosol' process

The only other solvent process which is used to any significant extent is the *Duosol* process. In this process, the feed is dissolved in propane and extracted with a mixture of phenol and cresylic acid. The advantage of

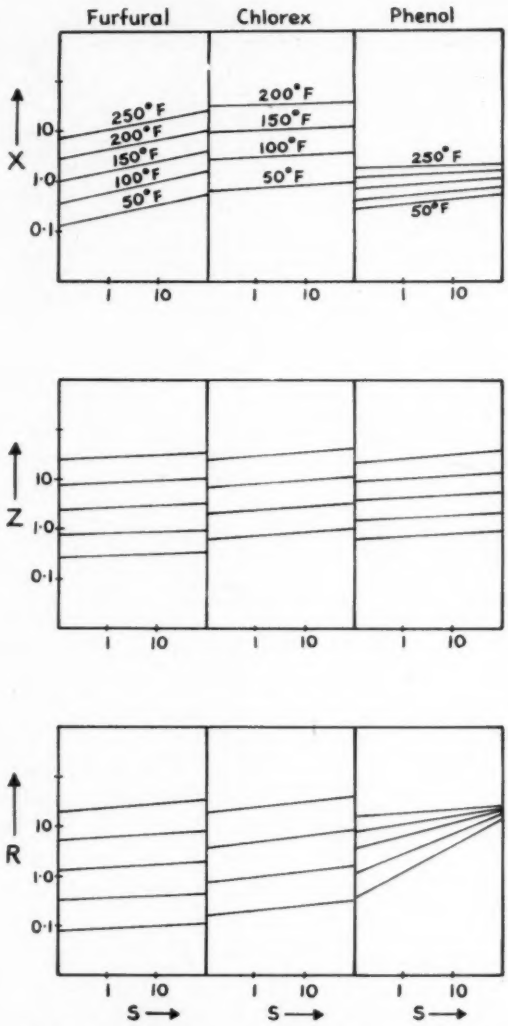

Fig. 5. Comparison of extractive properties of three common solvents (after Kalichevsky[3]).

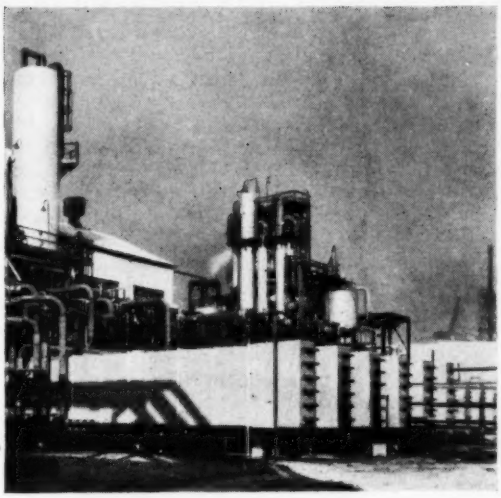

Fig. 7 (*above*). **A view of the MEK dewaxing plant in a large American refinery showing the double-pipe chillers and, in the background, the solvent recovery unit.**

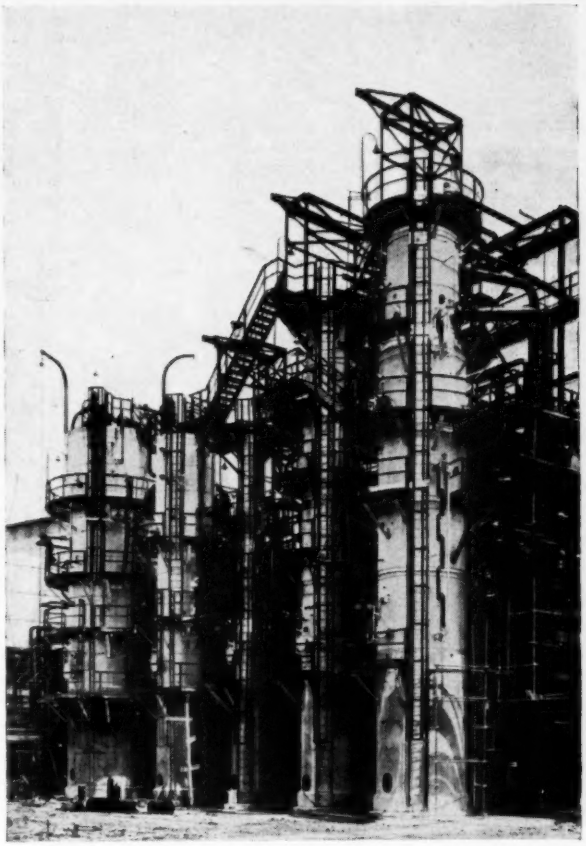

Fig. 8 (*right*). **The importance of solvent recovery for the economic operation of the processes described in this article is illustrated by this photograph. These fractionation towers are used to recover the MEK-benzene solvent in the largest dewaxing plant in the world, on the American Gulf Coast. The towers have a combined design capacity of 46,000 bbl./day.**

this process is that de-asphalting occurs simultaneously with extraction, but the attendant disadvantages make it merely competitive with the other processes. Thus the process must be carried out in a mixer settler system, as the possibility of precipitate formation rules out the use of packed towers and the recovery of solvents is complicated by the necessity for recovering them separately.

The original application of the *Duosol* process was to the treatment of long residua and thus its use involved a distillation cost saving. It later became apparent that the different characteristics of solvents towards the light and heavy components of an oil made it more economic to treat narrower cuts. It now seems preferable in most cases to use a de-asphalting system working in conjunction with a single-solvent process rather than the *Duosol* process, although the Shell refinery at Stanlow uses the latter process.

Dawson[5] gives the average cost, for equal throughputs, of propane de-asphalting followed by single-solvent extraction, as compared with *Duosol* treating, to be as follows:

Capital costs	1:1.04
Operating costs ..	1:1.2

The use of the *Duosol* process becomes more economic when it is intended to follow it by propane dewaxing, as it is then not necessary to remove the propane thoroughly from the waxy raffinate.

World usage of different solvent processes compared

The relative popularity of the various solvent processes is shown by the following table, also due to Dawson, which gives the percentage of the world's capacity for lube oil production in 1950 due to each of the processes:

	%
Furfural	42
Phenol	28.5
Duosol	17
SO_2 and SO_2—benzene ...	7
Chlorex	7
Nitrobenzene	1.5

A more recent survey indicates a further increase in favour of the furfural process:

	No. of plants	*Capacity bbl./day*
Furfural	41	143,000
Phenol	20	71,000
Chlorex	6	6,000
Nitrobenzene ...	2	3,000

Dewaxing

The earliest method of dewaxing was to settle the waxy oil in storage tanks during winter and to draw off the chilled clear oil from the separated wax. Development led to chilling the oil by refrigeration and filtering off the wax. In view of the high viscosity of the wax-oil mixture, naphtha was added both to facilitate the precipitation of wax and to allow filtration to proceed at practicable rates.

This simple scheme is complicated by the fact that the wax associated with the heavier oil fractions separates in a micro-crystalline, non-filterable form known as petrolatum and this is still the case in the presence of naphtha. Petrolatum therefore has to be removed by centrifuging and, as the naphtha-oil solutions are of lower density than the wax, a fairly complicated centrifuge is necessary, having

provision for removal of solid wax at the circumference. Since the filterable crystalline wax associated with the light oil fractions causes blocking of the wax outlet of such a centrifuge, the oil had to be dewaxed in two fractions. The presence of appreciable quantities of either fraction in the other had to be avoided and thus it was often necessary to reject altogether an intermediate 'slop' cut.

The development of other solvent methods was delayed until reclamation methods were efficient enough to make the processes economic. Thus, until the advent of the first commercial benzene-acetone process in 1929, two dewaxing methods were necessary for the production of a full range of lube oils.

Properties of dewaxing solvents

A suitable dewaxing solvent has as its characteristic property the power of rejecting the most paraffinic components, *i.e.* the waxes, and simultaneously keeping in solution the less-paraffinic components. Thus many of the solvents suitable for extraction are also good dewaxing solvents. An ideal dewaxing solvent should possess the properties:

(*a*) Complete miscibility with the oil at the separation temperature and low solubility for wax.

(*b*) At temperatures not too far above the separation temperature it should dissolve the wax completely—to ensure uniform mixing and distribution.

(*c*) The solvent should precipitate the wax in such a form that it can be easily removed. Together with properties similar to those of the ideal extractive solvent, such as low boiling point, low latent heat, low cost and lack of corrosive properties.

Single solvents in general seldom have the solubility characteristics towards both wax and oil which would make them suitable as dewaxing agents. By selecting two solvents, one of which has low wax solubility and the other high oil solubility, and blending them, a double solvent with optimum properties for the given stock can be obtained. Thus acetone, methylethylketone (MEK), ethylene dichloride and furfural, all having low solubilities for wax but also low miscibilities for oil, may be blended with toluene or benzene, which are completely miscible with both oil and wax.

A single solvent may have the desired characteristics by reason of its correctly adjusted molecular structure, as is the case with trichlorethylene. It is interesting to compare the properties of this solvent with those of other chlorinated paraffins, *e.g.*

Ethylene dichloride:
$CH_2Cl.CH_2Cl$, wax soluble, oil insoluble

Trichlorethylene:
$CHCl:CCl_2$, wax insoluble, oil soluble

Chloroform:
$CHCl_3$, wax soluble, oil soluble

Obviously a double solvent is more flexible to deal with varying stocks than is a single solvent.

Propane as a dewaxing solvent

Researches on the dewaxing properties of the naphthas indicated that, for hydrocarbons lower than the pentanes, the wax solubility decreased with decreasing M.W. This led to the development of propane as a dewaxing solvent. Although this solvent still has a comparatively high wax solubility, thus necessitating large dewaxing differentials, these differentials are considerably less than for naphtha (25 to 35°F. as compared with 40°F. or more). Added to this, the wax is deposited in a filterable form from both light and heavy stocks; the rate of chilling the solution has much less effect on the filterability of the wax (2°F./min. is permissible, as compared with 2°F./hr. for naphtha).

The advantages of propane which make it competitive with MEK-benzene are that cooling is obtained economically by evaporation of the propane and that it can be reclaimed in the refinery gas recovery system, thus obviating the need for an additional solvent recovery plant.

The MEK-benzene process, which is at present the most used solvent process, has replaced the original acetone-benzene (BA) process because MEK is cheaper and has slightly better solvent properties. The MEK-benzene mixture has the advantages of flexibility, of being easily reclaimed and of giving very small, or even, in some cases, negative dewaxing differentials. For operation at very low temperatures at which benzene would solidify, this component is partly or completely replaced by toluene.

Nelson[4] gives the following figures for world capacities of various solvent

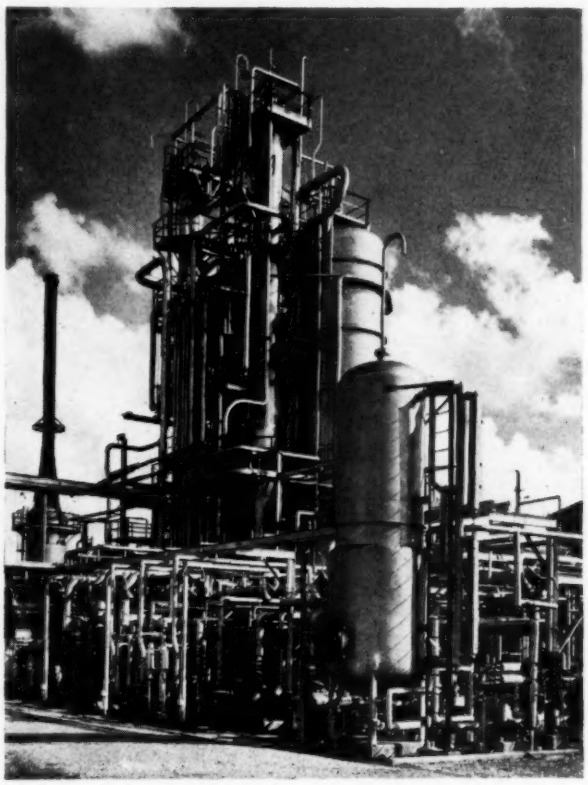

Fig. 6. The solvent-treating plant in an English refinery. Phenol is used as solvent and the plant has a charging capacity of 7,500 bbl./day.

dewaxing processes:—

	1947 *capacity*, *bbl./day*	1947	*Number of plants Under construction*
MEK-benzene	45,300	22	12
Propane	13,300	6	3
SO_2-benzene	2,400	3	0
Barisol	4,700	3	0

Sequence of operations

The sequence in which the operations de-asphalting, solvent extraction, dewaxing and decolorising are carried out is decided on economic grounds. The de-asphalting process is almost invariably carried out first, as the presence of asphalt would interfere with solvent extraction by leading to emulsification difficulties. It may, however, be combined with solvent extraction, as in the *Duosol* process, or with propane dewaxing when this is carried out before extraction. In the latter combination the precipitation of the asphalt is carried out first at elevated temperatures (100 to 150°F.) and the dewaxing occurs after chilling. It is usual in modern installations to de-asphalt separately.

Whether dewaxing should precede or follow solvent refining must be decided by taking into account the following factors:

(*a*) Dewaxing of the crude rather than the raffinate will lead to a higher load and thus higher capital and operating costs for the dewaxing plant.

(*b*) The inevitable loss of oil to the slack wax will consist entirely of the valuable high V.I. constituents in the case of raffinate dewaxing, whereas in the case of crude dewaxing roughly the same total loss of oil will consist only in part of the high V.I. constituents and these will be less valuable as no cost of extraction is involved. The loss of oil to the slack wax is increased by increasing the rate of throughput on a given installation, also by increases in the wax content of the oil. It can be reduced in the MEK-benzene process by alterations in the composition of the solvent.

The losses of oil in contact filtration (decolorising) are very small, and thus no detailed economic balance is necessary to indicate that it is cheapest to decolorise in the last step, when the load is smallest.

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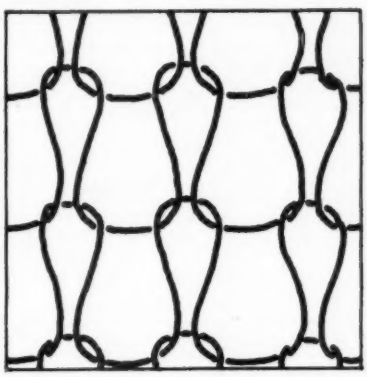
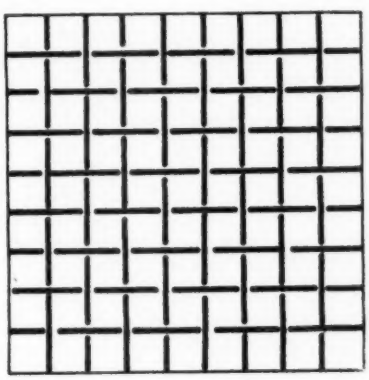
Knitted Mesh in Demister Design

KNITTED mesh can be made from most metals and plastics and has a wide range of applications, from air filters, electronic shields and petrol-vaporising sponges to mist eliminators, breathers and vibrator cushions. New products in this material which should be of interest to chemical engineers are now being manufactured by Knitted Mesh Manufacturing Co. whose *KnitMesh* is not to be confused with woven wire mesh in as much as it is made from one or two separate threads interlocking in a linked loop structure giving an asymmetrical mesh.



A



B

These two diagrams illustrate the different construction of (*a*) 'Knitmesh' and (*b*) woven-wire mesh, as explained in the article.

KnitMesh is manufactured in a stocking shape and has both a large surface area and a high percentage of free space, as much as 95%. Coarse-stocking knitted plastics mesh is manufactured in such materials as nylon, PVC and polythene, while medium and fine mesh is produced in nylon, *Saran*, and *Grilon*. Aluminium, *Monel*, stainless steel, copper, brass, and galvanised steel are used in coarse-stocking knitted wire mesh, and the medium and fine-wire mesh is manufactured in phosphor bronze, beryllium copper, brass, nickel, *Monel* etc.

High-efficiency entrainment in demisters

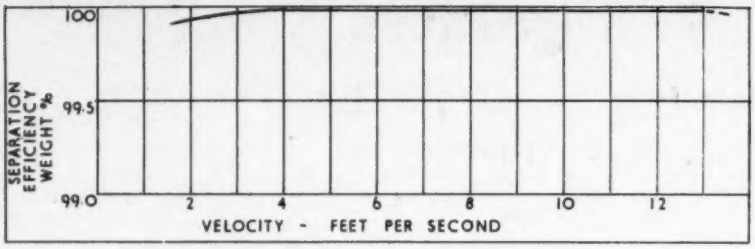
Because of its large surface area and high percentage of free space, *KnitMesh* is ideal for use in demisters. The demister is supported within the vessel on suitable grids having a high percentage of free passage. Since *KnitMesh* is resilient, a good fit to the vessel wall is obtained without difficulty, ensuring a high degree of efficiency.

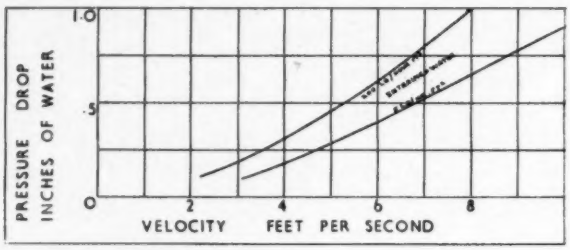
The liquid particles are held when they strike the wire surfaces, and the drops flow downwards and collect at adjacent wires, flowing downwards again when these collecting points become overloaded. Surface tension holds the liquid at the bottom surface of the demister until drops are formed which are large enough for the force of gravity to exceed the combined forces of velocity and surface tension. The drops will then fall away against any reasonable velocity.

Removal efficiency is 99 or 100% under usual operating conditions. The pressure drop is normally less than 1 in. water gauge, due to the approximate 98% free volume of the demisters. Alternative meshes can be selected for any particular application. The wire diameter is selected to cost, separation efficiency and strength requirements. To obtain higher separation efficiencies, the diameter of the wire is decreased and the density and the thickness of the demister increased.

Designing for high efficiency

There is no doubt that both good and bad demisters can be produced to the same reasonable paper figures, due to uneven density, for the following reasons:





Liquid entrainment separation efficiency from air or steam, and pressure drop, for a 4-in.-thick, 12-lb./cu.ft. wire mesh demister at standard conditions.

(1) Wires lying in parallel or too close together, obscuring impingement areas.
(2) Gaps at joints and sides of vessel.
(3) Grid support area too large.
(4) Irregular folding or winding.

To produce an even density, certain principles should be observed. Thus, there should be an even stitch in the mesh. The loops should be symmetrical, the width equal to the height, and equal to the distance between loops, except for particular purposes. This rules out heavily pulled down or stretched meshes.

The mesh should be crimped to ' open up ' layers and wires realigned, so that even laying does not provide straight-through holes through the loops. Additionally, for the same surface area, crimped wires lying at an angle will provide less pressure resistance than wires at right angles to the flow. The crimping should be reversed between layers to open up the layers further, and ideally the two layers of mesh in each stocking be repositioned, to keep wires from shielding each other's surface area, obtain maximum free volume, even density, and resilience. Wound-type demisters should have a ' herringbone ' crimp to avoid straight-through holes at the angle of the crimp.

Demisters must be oversize, 2 in. up to 36 in. diam., and proportionately, over that diameter. The top layers of sectional or flat demisters should preferably be laid at right angles to the lower layers to avoid any possibility of straight-through areas of low or high density.

Grids must have a free area of at least 90%, to give full credit to the free volume of the demister. They must also allow liquids to drop away easily from the lower surface of the demister.

Finally, folding or winding must be even.

RECENT PUBLICATIONS

Glass for industry. Q.V.F. Ltd., Duke Street, Fenton, Stoke-on-Trent, have published a fully-illustrated, 130-page catalogue of their industrial plant in glass. It gives details of the range of basic interchangeable chemical plant units in regular production; from these units can be assembled various complete plants, stills, fractionating columns, reaction units and pipeline layouts. All equipment listed is manufactured with buttress ends and couplings to British Standard Specification 2598 : 55.

Sway braces. A pamphlet from Vokes Genspring Ltd., Henley Park, Nr. Guildford, Surrey, gives full technical details of the construction and performance of their non-resonant sway brace, which is designed to prevent sway and control horizontal vibration of piping systems, without confining the natural thermal movement or adding objectionable stresses.

Breather-type transformers. Factors governing the maintenance of breather-type *Pyroclor* transformers are listed in a publication of the Sales Development Group, Monsanto Chemicals Ltd., 10-18 Victoria Street, London, S.W.1.

Metal coating. A descriptive leaflet, published by Albright & Wilson (Mfg.) Ltd., 1 Knightsbridge Green, London, S.W.1, describes *Kanigen* plate, an entirely new hard and corrosion-resistant metallic coating for most metals in general engineering use, that can also be applied to glass, ceramics and thermo-setting resins. The process was described in CHEMICAL & PROCESS ENGINEERING, 1955, **36** (11), 401. Articles that have already been plated in Britain by the new process include; aircraft valves, chemical valves, heat-exchanger tubes, laundry equipment and pumping equipment designed to handle corrosive liquors etc.

Oil for heat transfer. An oil having a high resistance to thermal cracking, *Mobiltherm* 600, which was specially developed for heat transfer systems, is the subject of a booklet from Mobil Oil Co. Ltd., Caxton House, Westminster, London, S.W.1.

Screens. Vibratory screens and mechanical handling plant, manufactured by Niagara Screens (Great Britain) Ltd., Straysfield Road, Clay Hill, Enfield, and designed for special duties, are described in an illustrated pamphlet.

Corrosion proofing. Selecting the best corrosion-proofing methods and products, determining comparative resistance of various cement mortars and calculating quantities needed, are outlined in a revised, up-to-date edition of a corrosion-proofing brochure from Pennsalt Chemicals Corporation, Three Penn Center, Philadelphia 2, PA, U.S.A. The 8-page illustrated manual contains tables giving detailed information on Pennsalt's line of corrosion-proofing cement mortars, interliners, protective coatings and linings.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Flameproof control equipment

The application of a range of process control equipment to oil refineries and other plants where operation in hazardous atmospheres is required has led to the design by the same manufacturer of certain types of auxiliary equipment which conform (and, where applicable, are so certified) to the various types of safety requirements.

Float-operated level alarm switches are available in different versions suitable for fitting to pressurised and other tanks. The use of magnetic linkage dispenses with the need for glands, thereby overcoming difficulties with respect to spindle friction and leakage. The magnetic linkage is arranged to produce snap action and permits the exact determination of the operating point of the switch.

Flameproof junction boxes are manufactured to match the electrical equipment and are considerably smaller than similar units designed for light or power applications. This is of major importance in complex instrumentation schemes where a multitude of connections may have to be made in a strictly limited space. They also offer distinct advantages where single boxes are required, as they are arranged to be easily fitted in difficult locations. The junction boxes are available with three, six or twelve terminal blocks, all constructed in aluminium silicon alloy with steel inserts in the cover screws etc. They are certified flameproof for Group II gases.

Alarm cancellation switches, which were specially developed in conjunction with certain comprehensive warning installations in major process plants involving hazardous operating conditions, are also available. These switches are flush-mounting, push-button, automatic resetting type and are also Buxton certified for Group II gases. **CPE 678**

Powder mixer

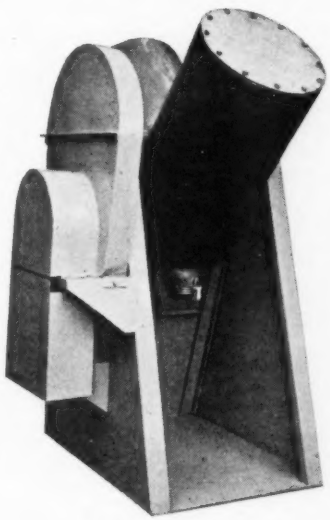
A new type of dry-powder mixer gives increased efficiency combined with mechanical simplicity. It has the three essential qualities of high yield, low cost price, and ease of cleaning.

The mixer consists of two receptacles, generally cylindrical, fitted together in a V shape, with an opening for filling and emptying at the base of the V, normally kept firmly closed. This mixing chamber is mounted on a horizontal axis driven by a geared motor, and turns in the plane of the V at a slow speed, which varies according to the model.

As the container turns, the powder falls from one arm of the V to the other, and the dividing action is enhanced by various-shaped baffles fitted in its path. In the second phase of rotation the powder rolls down the slope of the V, breaking up the layers formed in the first phase.

This apparatus is claimed to produce an intimate mixture at high speed, with low power consumption. There is no danger of contamination, since the vessel is completely enclosed, and the yield is much higher than in previous models.

The mixer is available in a range of sizes from 10 to 1,500 l.; the mixing chamber is made in steel (with or without interior lining), stainless steel or plastic, to avoid problems of corrosion and abrasion. **CPE 679**



Dry-powder mixer.

Solvent with a future

A new solvent, dimethyl sulphoxide, is being produced by a Swedish company and is available in the United Kingdom. The sulphoxides have proved extremely effective solvents

C.P.E.'S MONTHLY REPORT AND READER SERVICE

with high selectivity. Dimethyl sulphoxide is strongly hygroscopic and its unusual solubility properties suggest that it will be suitable for a range of special applications, such as a solvent for cellulose esters, a solvent and selective absorbent for acetylene and sulphur dioxide, as a solvent and recrystallisation agent for organic acids, as a selective separation medium for aromatic and paraffinic hydrocarbons, as a spinning liquid for acrylnitrile, proteins and cellulose acetates etc.

CPE 680

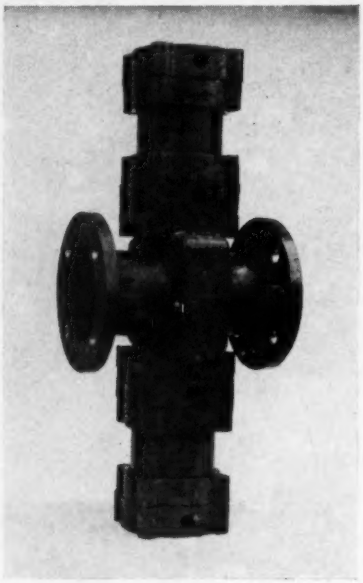
Steam trap

A new design of an inverted-bucket steam trap has been produced for those who require a small trap with copious discharge. Made in cast iron for pressures up to 200 p.s.i.g. saturated, it has a double-leverage action which enables large-diameter seatings to be used and gives a large capacity to size ratio.

It is available in sizes of $\frac{1}{2}$, $\frac{3}{4}$ and 1 in., and all internal fittings, with the exception of the copper float, are of stainless steel. A strainer element, devised to prevent grit entering and damaging the valve and seating of the trap, is also obtainable. **CPE 681**

Pinch valves

Pinch valves are available for air operation and electric operation, the basic design consisting of a rubber tube with a clamping mechanism housed in a metallic body. The rubber tube, which isolates the medium handled from the metal body and working parts, is available in a wide range of natural and synthetic rubbers, suitable for a great variety of corrosive substances. Designed without protrusions or pockets, it provides a straight-through, unobstructed flow, thereby eliminating clogging and reducing wear when handling abrasives.



Air-operated pinch valve.

This design is particularly suitable for handling powders in bulk or in suspension in air, as well as thick abrasive slurries, sludges etc. The fact that the lining is so easily replaceable makes the valve attractive for all corrosive applications, according to the makers.

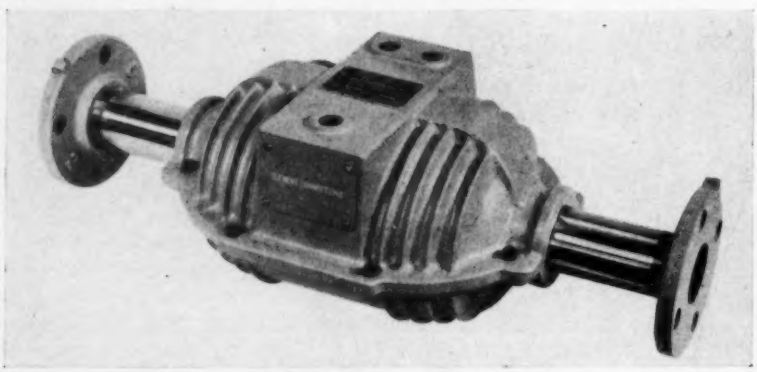
Two designs of air-operated pinch valves are now in production, one for on/off duties and another, of a newly introduced design, providing flow control. Electrically operated valves are also produced and the makers have recently supplied a 3-in. valve complete with electronic control gear to regulate the rate of flow automatically.

CPE 683

Magnetic flowmeter

A magnetic flowmeter has been developed to measure the flow rate of electrically conductive fluids such as corrosive acids or sand and water slurries.

It comprises a transmitter and a *Dynalog* flow receiver, which may be an indicator or recorder. The flow scale is uniformly linear and the meter has a range of 100 to 1. The transmitter itself consists of a stainless-steel tube through which the liquid passes, an electrical insulating liner on the inside of the tube, an electro-magnet which induces a magnetic field across the tube and two metallic electrodes which are flush with the inside surface of the tube. **CPE 682**



Magnetic flowmeter.

Lifting and handling equipment

A range of electric hoists and cranes provides a solution to problems of handling chemicals and raw materials. A crane-suspension track system allows access to remote corners of the bays of a plant and leave the floor area free for other equipment. Such a system consists usually of travelling trolleys or suspension crabs moving along on suspension tracks with the load attached, whereby curves may be negotiated without difficulty. The crabs, so far controlled from a cabin or from the floor by means of a suspension cable, are nowadays often operated automatically. This proved an advantage for the continuous flow of the production process, since due to a precisely timed circulation all production and transmitting steps can be strictly adhered to.

The crab suspended from suspension tracks can call at the various production stands in a line service, and may further cross over to branch-off tracks, through slewing switches and turntables. Through cross-over pieces provided with safety locking devices the crab may also traverse upon the crane girder of a suspension crane. Such a crane girder may be suspended

from two, or if a particularly long girder is concerned, from several runways (crane girders with a length up to 650 ft. have been erected successfully), thus covering any point below in the crane-field. With the lifting and handling operations remaining constant, various suspension crabs fitted to suspension tracks and suspension cranes can be controlled automatically. **CPE 684**

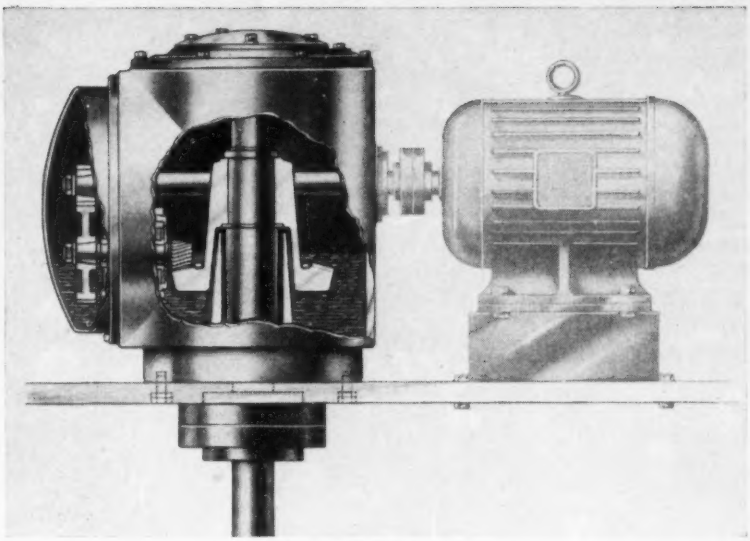
Infra-red oven

Many firms have a need to heat-process small articles and materials in batch production and a new infra-red oven has been specially designed for this purpose. It is suitable for pre-heating, paint stoving, drying of lacquer, removal of moisture from chemicals and foodstuffs etc., curing and softening plastics and the drying and activation of adhesives.

The oven consists of a sheet steel casing using infra-red tubular sheathed heating elements in trough-shaped anodised aluminium reflectors in the top of the oven which heat the material on a shelf by direct radiation. To conserve any stray radiant heat, the sides and floor of the oven are also lined with aluminium sheet.

The oven is ventilated through louvres in the top cover into the surrounding atmosphere, with air intake vents in the base raised clear of the bench by means of small feet. Shelf guides are fitted at three heights to suit different applications.

Various items are available at a small extra cost for use with the basic design of oven, and these include an asbestos tray, wire-mesh tray, hinged front door, floor mounting stand, and an energy regulator control box. **CPE 685**



Agitator drive.

Spiral bevel agitator drives

Agitator drives now being manufactured are claimed to be the first gear units to be designed and manufactured in Great Britain for the express purpose of driving both vertical and side-entering, permanently-mounted agitators. The makers point out that agitator drives have hitherto been built up around standard vertical-type worm reduction units, or vertical geared motors, neither of which, it is stated, take care of the peculiar conditions which apply when driving long, vertical agitator shafts with considerable out-of-balance forces.

The new drives are designed for special conditions. They have an oversize output shaft which has supporting bearings spaced at wide centres. They are suitable for installation both on open tanks and vats, and closed pressure vessels, and can be used on tanks up to 20 ft. deep. The output speed of the drive can be changed easily, as there is a wide range of spare helical gears available.

The new drives offer high gear efficiency, dry-well lubrication and they do not leak. Any existing motor can be used and they can be provided for any shaft extension, taking all external thrusts. They are available with or without agitator shafts or paddles or turbines. Compact design, ensuring that they occupy a minimum amount of head room, is a further feature. **CPE 687**

Blow your own glass

A portable glassblowers' kit of particular interest to the laboratory worker has come on the market. It provides a nucleus stock of interchangeable ground joints and other glass components for general-purpose glass-blowing.

The set comprises 32 cones, 28 sockets, and 49 other components including three high-vacuum stop-cocks and a complete set of tools.

The glassware is mounted on two panels, flexibly supported in a carrying case which provides shock-proof protection in transit or storage. A further advantage of this arrangement is that all components are visible at a glance so that the required piece can instantly be picked out from its spring clip, without any necessity to unwrap it or dispose of bulky packing material. Parts can be replaced immediately after use and the case provides permanent storage.

The new kit, which contains standard parts price-listed at £19 10s. 6d., costs only £20 complete, and so, the makers point out, the glassblower gets the case and tools for less than 10s. **CPE 686**

Factory services organisation

When planning any process involving the use of heat, or the movement of air, it is necessary to review the factory's present and future requirements, and its existing heating potential, together with the question of thermal insulation, orientation, and heat-reclamation possibilities.

The control of temperature, humidity, dust, bacteria and odour is an essential feature of many manufacturing processes, and a detailed investigation is required of the problems involved, before an effective and economical plant can be designed. To meet a demand for a manufacturing organisation able to advise on the

diverse aspects of factory services and to provide a comprehensive co-ordinated technical service to industry, a British firm have created an air-treatment division which will work closely with their existing heating and industrial divisions.

They will be able to advise, design and supply plant for full air conditioning, ventilation, heating, dust collection, fume removal, spray booths, drying ovens and process piping. **CPE 688**

Heat conservation service

A British industrial group is now offering a complete refractory and thermal insulation service, with a mobile team of experts prepared to travel to any part of the country at short notice.

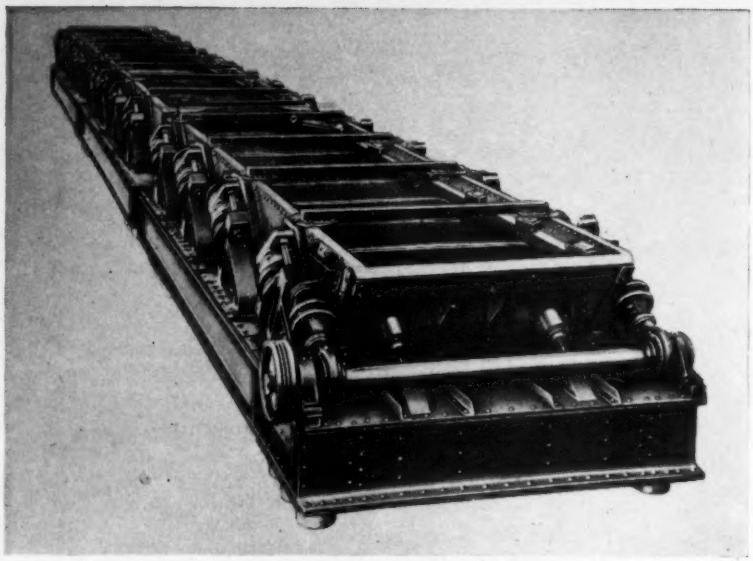
All internal insulation and outside lagging is covered by the service, and the group claims that the initial cost can be saved within a year. **CPE 689**

Glass valve for pressure relief

A glass pressure-relief valve provides a safe and effective means of reducing excess pressure. It is particularly intended for use with glass or enamel-lined vessels when it ensures continuity of the lining, and avoids the risk of metallic contamination of the product. It is designed to operate at a relief pressure of 15 p.s.i. and has an effective bore of 1 in.

The valve consists of a glass spherical joint, the ball portion of which supports a lead weight. Pressure or vacuum inside the vessel is maintained by the seating of the ball in the cup part of the joint, which is precision-ground. When the pressure in the vessel overcomes the pressure exerted by the lead weight acting *via* the ball it will lift this out of the cup. The ball has its seating recessed to increase the cross-sectional area through which pressure release can take place when the valve operates.

The lead weight has been designed both to ensure correct seating of the ball in the cup and also to provide protection if the contents of the vessel discharge under pressure through the valve, or if the glass components fracture. The valve can be exposed for cleaning by simply lifting off the lead weight and with it the ball part of the glass joint. **CPE 690**



Resonance screen.

High-speed resonance screens

High-speed resonance screens which have been developed and tested over a wide field of application by the German patentees are now being manufactured in the United Kingdom. They are to be available in six different widths from 4 ft. to 7 ft. 4 in. and in units of length to suit the material being handled.

The upper limit for the length of one unit is generally in the region of 22 ft., and where longer screens are required two units may be arranged in tandem. Inputs of up to 400 tons/hr. can be handled, depending of course on the density and size of the material and the vibration characteristics may be readily modified to suit the material and screening application.

In addition to normal high capacity screening, this equipment is well suited to dewatering; slime removal, and similar applications and the clean lines of the tray make the screen easily adapted to the fitting of hoods for dust removal, leaving the suspension and drive accessible for inspection and maintenance. **CPE 691**

THERMOMETER IN PLASTIC

Specially designed to meet the needs of the plating trade and industries where steam, acids or other corrosive fumes shorten the efficiency life of a thermometer, this vapour-pressure-type thermometer has a 4-in. easily-read dial completely housed in a Bakelite *case with screw-on front.*

The plastic-coated 6-ft. capillary and bulb is claimed to give the product lasting efficiency. The thermometer, which can be wall mounted, has a range from 30 to 150°F. **CPE 692**

Portable metal detector

Portable metal detecting equipment comprising a hand unit and earphones is now available. The unit, only 4 lb. in weight, is passed over the surface or object suspected of containing metal, the oscillator volume increasing when metal is directly beneath the hand position.

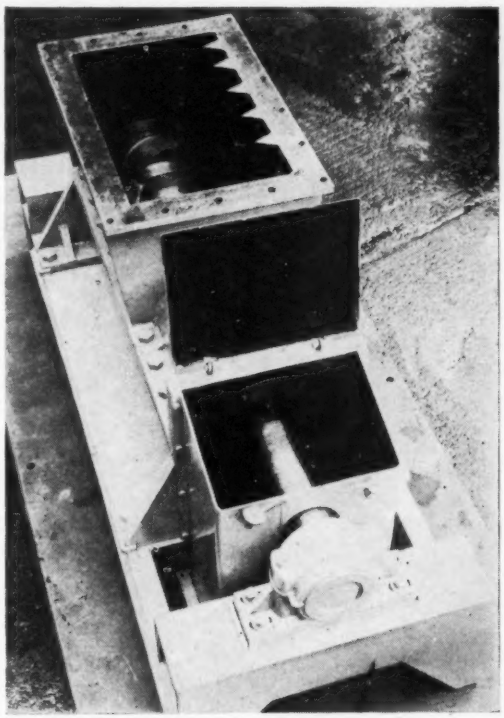
The apparatus is very simple to operate and it can be used for detecting metal-reinforcing in concrete, metal in timber, hidden metal roof-supports in mines, etc. **CPE 693**

Prebreaker

For the preliminary size reduction of large pieces of material, a prebreaker is available which will produce a maximum size acceptable as feed by a disintegrator of the same range (see **CPE 658,** July issue). It can be fitted as an integral part of the machine, or can be operated as a separate unit.

The prebreaker is a heavy-duty machine utilising high torque and low speeds. It is designed for heavy crushing, skin shredding and hogging treatment before disintegration. The machine gives maximum resistance to shock loads, while requiring minimum maintenance. Hammers on a rotating shaft pass between fixed anvils fitted to the body. Material caught between anvils and subjected to the impact and compression from the hammers is sheared or crushed.

This performance is repeated continuously as the product passes along the length of the unit. Since the machine usually runs at comparatively low speeds it develops high torque and has a minimum power consumption, with low operating costs. **CPE 694**



Heavy-duty prebreaker.

Fractionating column leak sealed during operation

An interesting repair was recently carried out on the leaking lower flange joint of a fractionating column at a coking plant. The leaking fluid was a light aromatic oil with a high concentration of naphthalene at 100°C.

Normal repair methods hitherto employed had meant the stopping of production, rigging of hoists, the partial dismantling and lifting of the entire column in order to fit a new packing joint. However, by the use of a proprietary sealing process this joint was sealed by the station engineering staff while the column was in full operation. The repair still holds good and is stated to have proved itself superior to previous jointings used.

Other successful in-the-field applications of this process have been made in sealing leaking joints in hot crude gas mains, caustic soda evaporators and high-pressure hot water lines.

Provided heat up to 240°F. is inherent in or can be applied to the leaking joint, and if the compound can be injected and held in the leak for 15 to 30 min. until it cures, it is claimed that the process will be effective in sealing most types of gas and liquid leaks. **CPE 695**

High-temperature cements

The *Brimor* range of high-temperature cements have a number of important properties such as good bonding to metals and ceramics, good mechanical strength, resistance to thermal shock and good electrical insulation.

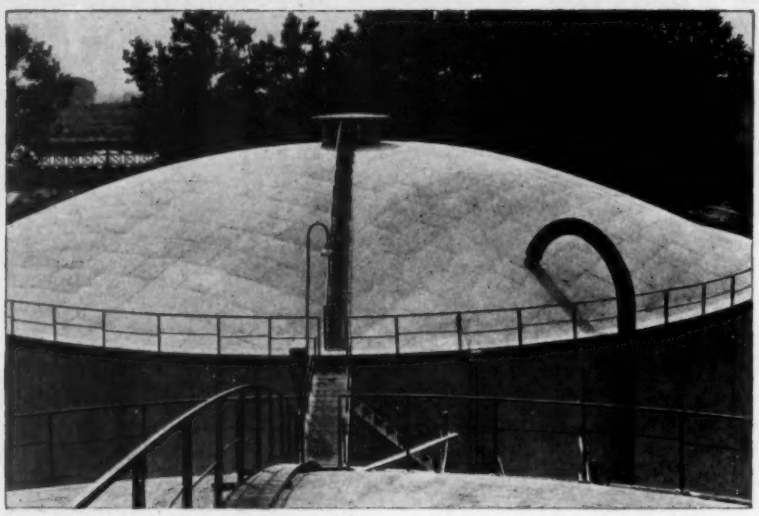
The cements are particularly suited to heat-resistant steels and *Nimonic* alloys and, when applied to these materials, have an operating range up to temperatures of the order of 750°C. They can, however, be applied with equal facility to the low-alloy steels, cast iron, and also to some non-ferrous materials such as brass, titanium, copper and aluminium alloys. In the latter cases the bond is not so effective as on steel, due to the effects on cement/metal bonding of surface oxidation of the metal at elevated temperatures. **CPE 696**

Voltage stabiliser

Voltage stabilisers of the electromechanical type have been produced which, while giving a speedy time of response, are very economical as regards outlay and cost of operation. One unit, for instance, will stabilise with an accuracy of $\pm 0.25\%$, a variation in input voltage from -20% to $+10\%$ with a load current from zero to 30 amp. and a frequency from 45 to 65 c/s. The response time for small errors is from 0.25 sec., while large errors are corrected at the rate of 12 v./sec.

Once set, the r.m.s. value of the output voltage is maintained constant throughout the year irrespective of fluctuations in the load current from zero to 30 amp. and of variations in the type of load power factor. No distortion of the wave form is introduced and the accuracy of the instrument is not affected by changes in temperature of as much as 20°C.

CPE 697



Storage tanks of the Italian Electricity Board, in Turin, protected with 'Rust-Anode.'

Rust inhibitor for cold galvanising

Rust-Anode is a 96% zinc rust inhibitor for cold galvanising. The manufacturers state that cold galvanising with this material is similar to hot galvanising. It has the advantage that it can be applied on site without dismantling operations, as it can be applied by either brush or spray. The same firm produces another rust remover and inhibitor for cases of very severe corrosion. This material, *Capalla*, neutralises existing rust and deposits a phosphate coat which provides a good key for the subsequent application of *Rust-Anode* or any other paint. **CPE 698**

Flexible heating units

For many applications where large areas have to be subjected to high temperatures, such as the heating of pipelines and vessels of all shapes and sizes, shell moulding, annealing processes etc., a flexible heater is claimed to represent an entirely new technique.

This heavy-duty heater is built up from a network of resistance wires insulated by specially constructed interlocking high-temperature-resistant ceramic blocks. It is designed to have a surface loading of up to 50 w./sq.in., and controlled temperatures of up to 1,000°C. are obtainable. The basic unit, the high-temperature-resistant ceramic block, functions independently of, but is securely attached to, its adjacent members. This ingenious construction allows such a high degree of flexibility that the heaters can be applied to parts having a diameter as small as $\frac{1}{2}$ in. At the same time, curvatures with a minimum radius of 24 in. can be accommodated in a direction at right-angles to the direction of maximum flexibility. In addition, dependent on the shape, dual curvatures can be successfully heated.

Rectangular heaters are available in sizes up to 48 × 48 in., and for all applications where the working surface area is greater, two or more heaters can be linked together. Heaters are also available in a variety of other shapes. **CPE 699**

'Flexible furnace' material.

Acid-resisting plumbing

A non-corrosive substance, *Vulcathene*, has been developed for use in plumbing installations. It is stated to be almost completely insoluble in all organic solvents, to return to its normal thickness after stretching, and to be suitable for uses where it is subject to stresses below the yield point, in compression or tension, at temperatures up to 158°F.

The material is available in standard coils of 50 or 100 ft. in diameters of from $\frac{1}{2}$ in. to 2 in. and in straight lengths up to a maximum of 60 ft. in diameters of $1\frac{1}{4}$ in. to 4 in. A range of fittings, including trap units, drip cups, drain fittings and diaphragm valves, is also manufactured.

A method of joining the fittings and piping, known as *Polyfusion*, has also been developed. **CPE 700**

Petrol gas generators

For laboratory, industrial and also domestic operations where gas is used, a range of petrol gas generators provide a source of supply. The generators produce a stable gas at constant pressure and consistency, both of which are unaffected by climatic changes or fluctuations in load demand.

Four types are available: the standard electrically-driven model and the weight-driven, portable electrically-driven and portable automatic electrically-driven generators, the outputs of which range from 100 cu.ft./hr. to 5,500 cu.ft./hr. Plants of even greater capacity are available. **CPE 701**

Large-scale comminuting mill

For size reduction, granulation and intense mixing of both dry and liquid products, a new large-scale comminuting mill is available. Of stainless-steel construction, it is normally driven by a 25- or 30-h.p. motor and speeds of up to 4,000 r.p.m. are standard.

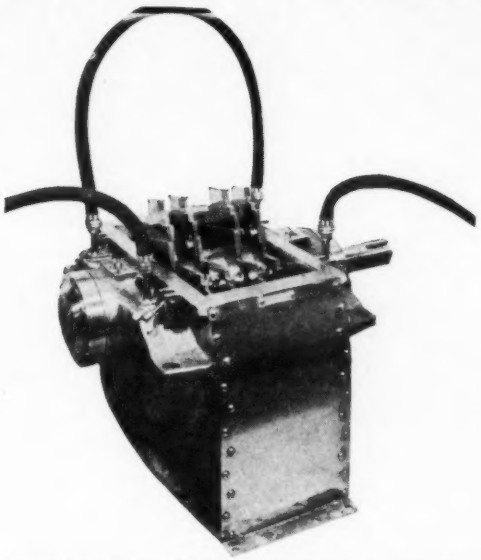
The machine consists essentially of a chamber, the lower part of which holds interchangeable screens. Eight types of screen in more than 60 sizes are available, ranging from 1½ in. to 300 mesh. Through the chamber is a shaft carrying a rotor to which a number of hammers, usually swinging, are attached. The rotor shaft bearings are located outboard of the chamber providing for maximum cleanliness, and the bearing grease seals are of the labyrinth type. Each bearing is fitted with a grease valve by which excess or utilised grease is simply discharged. The mill is normally operated with blades which have one face flat, to have a pulverising action, whilst the other has a knife edge to give a cutting action. Over 10 different dual-faced blades are available which enable a great many process problems to be solved.

The change from knife edge to hammer face is made by reversing the direction of rotation of the motor, and this involved the design of a universal type of feed throat with a venturi throat having a central feed opening.

Material to be processed is normally fed from a feed pan down a special feed throat to the high-speed blades and the material passing through the screens is caught in receivers. The operation is completely dustless when dry processing due to the use of a special air filter. Normally, no use is made of separate dust collectors or air separators.

The grinding chamber is built in two sections held together by swing bolts, the upper part forming the bottom of the feed throat. Whilst the chamber is easily opened, protective devices are incorporated to prevent the comminuting mill being opened when the blades are being driven.

CPE 702



Water-jacketed grinding chamber for the comminuting mill, showing the fixed blades with removable stepped blades, the tips of which are faced with tungsten carbide.

Electronic filing unit for data processing

A device for use with a computer is claimed by the makers to provide 10 times the capacity of any other electronic data processing equipment, and to permit bulk handling of all business records at far lower costs than by large-scale computers.

The *Datafile* stores 20 million characters in a single unit comprising fifty 250-ft. magnetic tapes. Up to 10 *Datafiles* can be integrated into one computer system. Binary information is calibrated into addressable blocks of 200 characters each. The tapes, housed in static-free metal bins, move backward or forward over guide rods at 60 in./sec. Records are automatically sorted out, processed and refiled. At a single programme instruction twin read-write heads are propelled beneath the tapes and stop at the designated position to read or write 1 to 100 blocks of information, at the rate of 46 msec./block. The computer automatically processes the data selected and restores the new records in their previous locations.

Tape capacity is effectively doubled through the use of two parallel lanes of six information channels each. Tapes can be written-on repetitively for spot-updating of information. A built-in checking code precludes transient errors, such as those caused by dust particles.

Perforations at the end of each tape actuate a vacuum switch which automatically stops the tape. This, with block addressing, prevents loss of information due to tape run-out. The tapes can be searched independently of the computer. **CPE 703**

Automatic fire detection

An entirely new approach to the question of providing extensive detection, whether automatic or manual, in an extremely large industrial site is embodied in a new fire-detection system. It is explained that the basic difference of the new system is in the manner in which virtually unlimited sectionalisation may be achieved without incurring ever-increasing labour and cabling costs.

In each fire area a small pulse box is placed and, when an alarm is originated in a fire area, the relays in the associated pulse box release, and an alarm signal is passed *via* the main ring circuit to the central control equipment. The switching equipment in the central control unit then operates and sequentially counts around the pulse boxes on the ring until the pulse box on which the fire condition exists is located. A return signal is then given from this pulse box over the ring circuit and the central equipment gives a permanent indication of the relevant fire area. This indication is given on the main display panel associated with the central control equipment and may be repeated, if required, to subsidiary indicator boards.

Once the alarm condition on that fire area has been accepted, the central

equipment reverts to an 'alert' condition, to locate any other outbreaks that may occur.

As the relays on the local pulse box are released and initiate the alarm cycle in the central equipment, local sections' alarms are automatically operated in the relevant evacuation areas. These alarms are powered from a local source which is independent of the supply to the central alarm equipment and is also independent of the mains supply in that evacuation area. **CPE 704**

Electronic system speeds industrial processes

Co-operation between two companies has resulted in advances in the field of computer-controlled flame cutting machines. The new equipment which will result from this link-up is claimed to be the first of its kind in the world, and is expected to have far-reaching application in chemical engineering.

As well as fully automatic operation of the profiling process, the system includes special features for controlling automatically the gas supplies to the cutting blowpipes, automatic ignition, pre-heat flame monitoring, nozzle height sensing and cutter-head rotation. **CPE 705**

Instrument panels

The *Lockmet* system of building instrument cubicles and panel installations has been evolved to meet the need of the engineer planning or replanning a control room layout. The units are designed to build from standard parts every type and style of instrument cubicle or face panel installation.

TURBO-REACTOR

This portable turbo-reactor, described in our July issue, can be mounted on channels or to the side of a vessel or against a wall. **CPE 643**

The system constitutes standardised interchangeable parts, easily assembled and providing a firm, rigid and highly finished instrument panel. Extensions can be made without disturbing existing installations. To extend a cubicle, *e.g.* from a 36 in. to a 72 in. width, it is only necessary to remove the side plate, adjust the position of angle supports, add the new front and entry units and refit the original side to the added units. **CPE 708**

STAINLESS-STEEL CLAD ROLLS

A new method for the external cladding of rolls, shafts, tubes and drums with stainless steel is now in production in Great Britain. This patented process, which has been fully proved on the Continent, is claimed to result in a perfect bond between the cladding and the foundation body.

The cladding process is particularly advantageous in the case of internally heated or cooled rolls and drums which, after cladding, are suitable for working in a very wide range of temperatures. The clad rolls can also be ground and polished to precision limits.

While stainless steel is the most usual cladding material, the process can be applied equally successfully to other similar materials.

Results already obtained indicate that this method of roll cladding will be of great benefit to a large number of industries. **CPE 706**

POCKETS FOR VATS

Closed-in tubes in PTFE, for use as electrode sheaths or thermometer pockets in chemical vats, are now available. **CPE 707**

Dual-purpose water steriliser

A new dual-purpose ultra-violet water steriliser for low volume drinking or process water has been introduced. It will treat up to 400 gal./hr. of water as a continual flow unit; and its lamp assembly can be quickly detached from the outer chamber and used separately as an immersion steriliser for water tanks. For static tanks of, for example, 50 to 100 gal. capacity, the immersion unit will deal with a demand of about 300 to 400 gal./day. **CPE 709**

Molecular sieves

Molecular sieves for selective adsorption are now available. They consist of highly porous, dehydrated crystalline zeolites, with pores of molecular dimensions. Two synthetic zeolites are made, *viz.* sodium and calcium alumino-silicates, with pore diameters of 4 and 5 Ångstroms respectively. The most useful form of zeolite is in pellets of $\frac{1}{8}$ or $\frac{1}{16}$ in. diam., of which the larger is recommended for gas separations and the smaller for liquid-phase separations. Powder and granule forms are also available.

These molecular sieves are claimed to exhibit high adsorption capacity at low concentrations and at high temperatures. They adsorb small rather than large molecules, and have high affinity for unsaturated organic compounds and polar molecules, and above all for water. They can be regenerated without losing their structure.

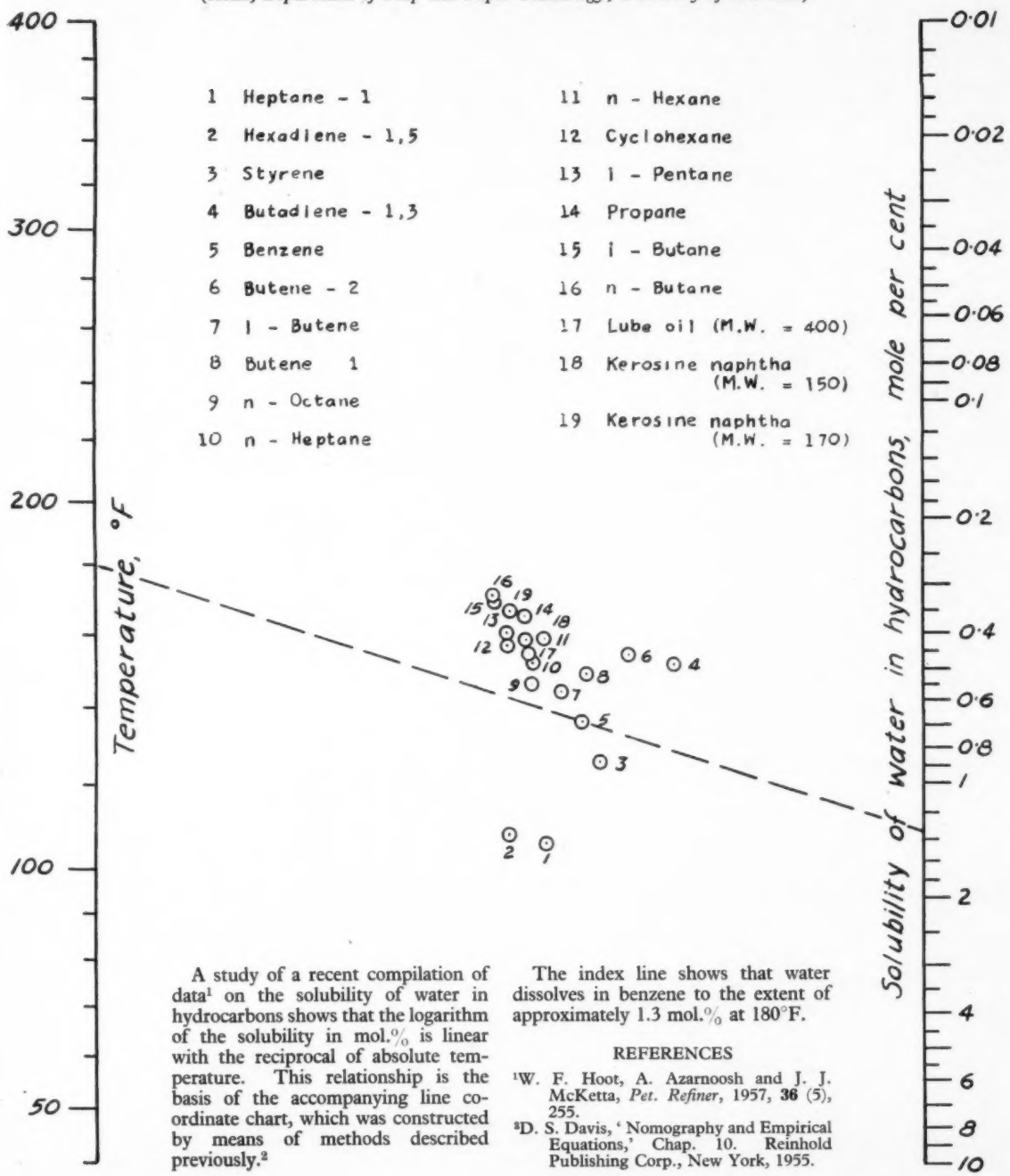
The main applications of molecular sieves are in drying and purification of gases and liquids, recovery of unsaturated molecules, separation of hydrocarbons, maintenance of vacuum and ion exchange. **CPE 710**

Nomogram:

Solubility of Water in Hydrocarbons

By D. S. Davis

(*Head, Department of Pulp and Paper Technology, University of Alabama*)



A study of a recent compilation of data[1] on the solubility of water in hydrocarbons shows that the logarithm of the solubility in mol.% is linear with the reciprocal of absolute temperature. This relationship is the basis of the accompanying line co-ordinate chart, which was constructed by means of methods described previously.[2]

The index line shows that water dissolves in benzene to the extent of approximately 1.3 mol.% at 180°F.

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Let's Look at ENGINEERING

A 16 in. valve of the Audley Engineering Co. Ltd. fitted with a 'Rotork' electric actuator.

While there are a number of firms specialising in the chemical engineering needs of various industries, there are also a number of engineering firms which serve industry on a wider front but which are no less alive to chemical engineering developments in certain fields. To see how the engineering industry has broadened its scope in recent years we only have to look at the exhibits to be shown at the Engineering, Marine, Welding and Nuclear Energy Exhibition, which is being held at Olympia, London, from August 29 to September 12. This gives a good example of the powerful influence that is exerted on engineering today by considerations of corrosion resistance, instrumentation, heat transfer, mixing, separation and many other matters which are primarily the concern of the chemical engineer. Below we give a preview of some of the exhibits to be seen on some of the stands.

Type C 660 carbon ring air compressor on the stand of Broom & Wade Ltd.

A standard 1½ lb. CX3 cast lead alloy anode with a threaded insert. CX3 anodes were developed by Cathodic Corrosion Control Ltd.

TO be shown for the first time in the United Kingdom, on the stand of Sharples Centrifuges Ltd., will be the vapour-tight *Super-D-Hydrator*. This is a specially developed form of the *Super-D-Hydrator* perforated basket fully automatic crystal **centrifuge,** designed for handling toxic, hazardous or inflammable materials. It permits the process materials to be kept enclosed during the enemy stage of the separating, washing and dehydrating operation, all of which may be carried out under a blanket of nitrogen or carbon dioxide if required. Models are available for handling materials under sterile conditions, so that on shut-down, sterilisation of all contact parts can be effected by steam or toxic gas.

Also to be exhibited by Sharples are a number of other processing centrifuges, oil treatment units, a model of the Sharples *Low-Loss* vegetable-oil-refining process and illustrations of a tar-dehydration process and a soap process. In addition, equipment for **particle size analysis** and for the classification of fine particles will be shown.

Langley Alloys Ltd. intend to demonstrate the flow efficiency characteristics of a standard 'Y'-type valve against those of a similar-sized globe valve by pumping water through each at full bore and measuring the pressure drop across each in turn by means of a differential-pressure meter. The full range of Langley **valves** will be represented, including gate, needle, check, globe and 'Y' type valves in *Langalloy* stainless steels and nickel alloys and in *Hidurax* aluminium bronze.

Also being demonstrated will be some interesting facts on the structure and properties of *Hidurax* aluminium bronze bar material and the particular advantages of bar produced by hot rolling. Samples of the wide range of bar materials available will be on show. A recent addition to this range is centreless turned bar with precision finish of ± 0.002 in. in long lengths, making it ideally suitable for marine propeller shafts.

The Audley Engineering Co. Ltd. specialises in the manufacture of lubricated taper plug **valves** for use in every section in industry. They are made in a wide range of engineering and chemical engineering materials of construction in sizes up to 24 in. and designed for controlling pressures from the finest vacuum up to 5,000 p.s.i. One of the features of the stand will be the application of power-operated, remote-controlled valves and these include both pneumatic and electrically actuated exhibits.

A turntable will be incorporated in the stand design and on this is to be exhibited a 16-in. class 600 carbon-steel gear-operated *Audco* valve of the type installed in the Iraq Petroleum Co.'s pipelines.

The Andre Rubber Co. Ltd. will show **rubber linings** for tanks and bends and flexible bellows-type pipework **expansion joints** of up to 60 in. inside diameter as well as machinery mountings for industrial and marine use and road expansion mountings.

The nuclear energy aspect of the exhibition is encountered on the stand of Babcock & Wilcox Ltd., the exhibits including a model of one of the 32 giant **heat exchangers** made for the Calder Hall and Chapelcross atomic power stations and a scale model of a typical welded pressure vessel for a reactor of the pressurised-water type. Conventional steam-raising plant is also represented and an exhibit referring to **oil-fired boiler** plant includes a model of Europe's largest oil-fired boiler and examples of different types of Babcock oil burners, including the new high-pressure return-flow atomiser specially developed for service on large central station and industrial boilers.

A new exhibit on the stand of Broom & Wade Ltd. will be the type C 660 dry cylinder, carbon ring, single-stage **air compressor** which has an output of 100 cu.ft. min. of free air at 100 p.s.i. This has been designed for a medium supply of oil-free air necessary in chemical, food processing and other applications where oil-free air is essential. They will also be exhibiting portable and stationary air compressors and pneumatic tools. The portable compressors will include examples of the *Broomwade* two-stage rotary air compressors which have recently been placed on the market.

Examples of lead alloy **anodes** which represent a great advance in impressed current cathodic protection will be shown by Cathodic Corrosion Control Ltd. These lead alloy anodes, known as CX3, operate with high efficiency from 2 to 30 amp./sq.ft. and at maximum efficiency between 5 and 15 amp./sq.ft.

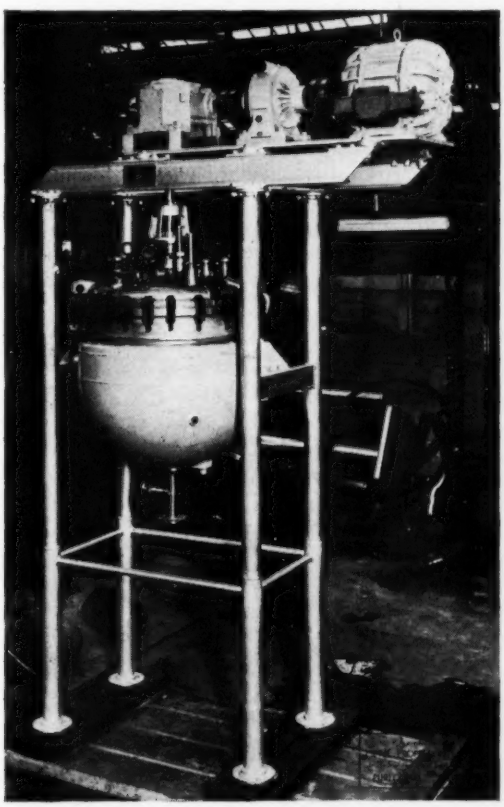
The alloy has been proved most effective in sea water or in water where resistivity is below 1,000 ohm/cm. The anodes are easily fabricated and mounted, and the mechanical toughness of the alloy is high compared with other anode materials such as graphite and silicon iron.

CX3 anodes have exceptionally low rate of consumption and much depends on the formation of a complex lead peroxide film which, being electrically conducting, causes the anode reaction to take place on its outer surface. This means that, following an initial consumption of the alloy to form this complex, it becomes virtually permanent and the corrosion of the metallic lead is greatly reduced. The anodes are being manufactured in three standard designs: castings, line and ribbon for various applications.

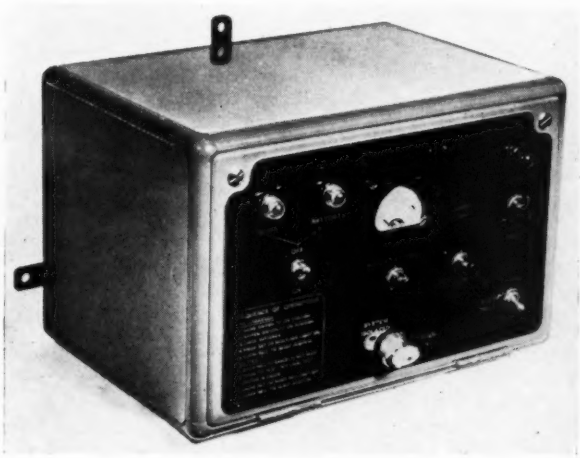
The overall emphasis of the display of Power Auxiliaries Ltd. will be on the important part being played in industry by their product *Plessiflex*, the metallic, seamless, **flexible hose.** Introduced as a method for overcoming problems associated with the conveyance of liquids or gases at high pressures between junctions which are initially malaligned, move angularly, vibrate or are exposed to high and low temperatures, *Plessiflex* also provides a simple solution to problems where difficulty in using rigid piping is encountered, and is used widely for the conveyance of corrosive chemicals and gas and for vacuum installations.

Zwicky Ltd. introduce an entirely new addition to their range of products. Demonstrated on the stand will be the new *Zwikleen* **self-cleaning filter** which is manufactured in a range of sizes with varying degrees of filtration. Another new product is the pressure control valve and pressure regulating valve.

Right: **A polymerisation reactor to the order of Shell Ltd. made and designed by Metal Propellers Ltd. The speeds are controlled by a 'Kopp Variator' produced by Allspeeds Ltd. who will be exhibiting their range of variable speed mechanisms.**



Below: **The electrical power unit which supplies D.C. current to fire the detonators of the Graviner Manufacturing Co.'s explosion protection equipment.**



Vokes Genspring Ltd. will feature their new 'M'-type **constant-support hanger** for marine installations and a range of sway braces especially suitable for the protection of large steamlines on ships subject to violent sway due to the motion of the ship. These are, of course, equally suitable for eliminating shock or vibration on steamlines, feed-water lines, exhaust lines, compressor lines and hydraulic lines. Their range of variable- and constant-support hangers, both H12 and W, will be shown as supplied to factories, power stations, refineries, nuclear reactors, and for any application where a thermal expansion problem arises in pipelines.

The parent company, Vokes Ltd., will show a wide range of **filtration equipment,** including a new product, the *Auto-Roll*, an automatic screen-type air filter for air-conditioning and ventilating systems which has its medium disposed between two rollers so that replacement of the dirty cloth is effected by a few turns of the lower roller.

K.D.G. Instruments Ltd. will be exhibiting a range of **instruments** including hydrostatic contents gauges and controllers suitable for all liquids including chemicals, and in addition a new 10-in. wall- or flush-panel-mounted hydrostatic tank contents recorder with a seven-day or 24-hr. electrical or mechanical movement, and the new twin and triple indicating contents gauge operated from a single transmitter.

Pressure switches with ranges from 0 to 1 in. to 5,000 p.s.i. including Buxton certified flameproof types, and in addition flameproof switches with stainless-steel elements will be shown, as well as thermometers including indicating, recording and controlling types, and a range of specialised pressure gauges including a new range of draught types and also a high static differential pressure gauge with overload protection.

On the stand of Ronald Trist & Co. Ltd. the *Electricon* **smoke alarm,** type A.S.B., now in production, will be exhibited as a working model. Simple and robust, this new instrument gives warning that smoke emitted from a chimney has exceeded a predetermined limit. A range of *Mobrey* magnetic **level switches,** constructed in various materials, will also be on view. These switches are now available for working pressures up to 3,000 p.s.i., and working temperatures up to 750°F., for use in almost any liquid. The latest addition to a range of level alarm equipment will be featured. This is one of a series of vertically mounted *Mobrey* electric high- and low-level alarms now available for steam boiler applications up to 450 p.s.i. working pressure. The series comprises 4-in., 6-in., 8-in. and 10-in. range alarms.

The Bell's Asbestos & Engineering (Holdings) Ltd. stand will feature **asbestos** specialities, valves and fittings, and industrial and marine insulation.

The exhibits of the industrial explosion suppression department of the Graviner Manufacturing Co. will include a pneumatic **explosion detector** for early pressure detection of explosions and *Armourplate* glass **bursting discs** for rapid and efficient relief of explosions. Hemispherical **suppressors** are accommodated internally and a 3-in. high-rate discharge bottle, which is accommodated externally, is for the suppression of explosions where the working temperature does not permit the use of the former. It is also used in cyclones where the installation of hemispherical suppressors would interfere with the operation of the cyclones. A $\frac{3}{4}$-in. high-rate discharge bottle is used for advance inserting in order to prevent an explosion propagating from one section of a plant to another.

Alfa-Laval Co. Ltd. are exhibiting plate-type heat exchangers in stainless steel and stainless-steel centrifugal pumps. Among the later types of centrifuge is the automatic self-opening separator. By means of a special hydraulic device, solids are ejected from the centrifuge bowl while it is running at full speed, thereby eliminating any shut-downs for bowl cleaning.

The De Laval nozzle separators for continuous two-way and three-way separation are represented by two machines, the larger of which is driven with a 65-h.p. motor.

Among the selection of mountings and pipeline valves to be shown by Dewrance & Co. Ltd. will be small-bore steel valves for pressures up to 600 p.s.i. and 875°F. A special feature is the fabricated body, the design of which eliminates conventional heavy cover flanges and bolting. Seats and disc faces are directly deposited with *Endewrance* hard-faced, non-corrodible alloy. Amongst other items on this stand will be *Stufline* valves for controlling 'stuff' to the beaters in paper mills and wood pulp mills and in chemical industries for the control of thick liquids and wet grain.

Fusible-link Ventilators Combat Fire Menace

Superheated air, it has been observed, is the vital factor in the destruction by fire of modern buildings hitherto considered entirely fireproof. It has explosive force and it dries out, instantaneously, all fibres and fabrics, igniting them like tinder. It creates pressure, together with great rushes and gusts of flammable air.

Superheated air, too, which precedes and surrounds all intensive fires, is responsible for the death of those victims of fire who have been found to be neither burnt to death nor asphyxiated by smoke or fumes. It is now known that two or three breaths of superheated air have killed many of the unmarked victims of fire.

Attention is drawn to these facts by Mr. M. J. Reaney, director of Colt Ventilation Ltd., in a bulletin which points out that the means towards the elimination of superheated air lies in the provision of ventilation for the escape of heat and smoke. An ingenious development described by Mr. Reaney, and which is finding favour in a number of factories in Britain and overseas, is a smoke hatch, complete with fusible link fire opening action, designed to function as a normal natural ventilator, so that, in addition to being available for day-to-day use, it will also, by virtue of its fusible link control, fall open immediately on the outbreak of fire.

Crystallisation

(*Concluded from page* 326)

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Chemical and Engineering Research in Australia

(Part 2)

This concludes the survey, begun in our July issue, of the research work reported by the Australian Commonwealth Scientific and Research Organisation for the year 1955-56.

INDUSTRIAL CHEMISTRY

Minerals utilisation

Certain phases of extractive metallurgy continued to form an important part of this work. Projects related to the recovery and purification of uranium, thorium, zirconium and hafnium derivatives from Australian mineral sources have an obvious relation to current requirements in nuclear energy developments. The continuing importance of the germanium in transistor devices has justified a survey of Australian occurrences of this element and has emphasised the necessity for improvements in processes for extraction of germanium from widespread low-grade sources. In this, as in the case of copper extraction, the advantages which may be expected to accrue from the development of hydrometallurgical extractive processes have been emphasised in the projects concerned.

Uranium extraction. Work has continued on the process whereby uranium is preferentially leached by sulphuric acid autogeneously produced from pyrite either present in, or added to, the core. In some locations this may well prove to be the cheapest way to provide the sulphuric acid needed. Detailed studies were made on the mechanism of acid generation from the pyrite as a basis for application of the process to other metals.

Major improvements were made in the design of the reaction vessel, particularly to enable adequate control of agitation and aeration during leaching. Non-pressure leaching tests were conducted on numerous Australian uranium ores to determine the respective merits of leaching under acid and alkaline conditions, at constant *p*H, and under ' acid-cure ' conditions etc. Particular attention has been paid to the influence of clay-like minerals on the yield of uranium obtained by acid leaching. The regeneration of nitric acid from barren liquors has also been examined with a view to inexpensive recovery of the acid.

Zirconium-hafnium separation. The chemical separation of the small amount of hafnium from the zirconium, with which it is always associated in minerals, is a necessary requirement if the zirconium is to be used for a cladding element for uranium rods in a nuclear reactor. The separation involves considerable chemical difficulties and the method devised in this laboratory is claimed to have notable advantages compared with processes currently in use in other countries. Pound-scale separation of zirconium and hafnium tetrachlorides by preferential reduction of the zirconium to the trivalent state has been developed into a semi-continuous process which has been patented.

Either aluminium or zirconium metal has been used to reduce crude zirconium tetrachloride to the involatile trichloride, and the unreduced hafnium chloride has been sublimed away. The hafnium-free zirconium trichloride has then been disproportionated *in vacuo* to give a sublimate of pure zirconium tetrachloride and a residue of involatile dichloride. This dichloride has then been used to reduce a further batch of crude anhydrous chloride for each reduction.

A mild-steel reaction vessel similar in design to the Kroll reduction vessel has been used for these investigations and has shown no signs of serious corrosion after 12 months' service. A programme of fundamental work has provided data on the reduction of zirconium tetrachloride to the trichloride. This information has made possible the recovery, in a single cycle of reduction and disproportionation, of more than 80% of the crude zirconium chloride as a product with a hafnium/zirconium ratio of 0.05%.

Thorium purification. Greatly increased attention has been paid over the last year to thorium because the fissionable isotope U^{233} can be made in an atomic reactor from thorium metal or suitable thorium compounds and therefore purification of thorium has acquired a new significance. Since metal of the highest purity is obtainable by thermal decomposition of the iodide, synthesis of the tri- and tetraiodides has been studied and preliminary kinetic studies made of the rate of iodination of crude thorium.

Physical chemistry

The properties of surfaces continue to provide fruitful subjects for study in fields as diverse as the coalescence of drops, the separation of uranium from slurries by ion exchange, the reduction of natural evaporation, and the mechanism of rubber reinforcement. The properties of materials at high pressure, particularly the effect of pressure on chemical reactions, the relation of the properties of liquids and liquid mixtures to their molecular structure, the chemical characterisation of carbons, and the fixation of nitrogen are other main lines of investigation. The work on flotation has been terminated in order that a study may be initiated of the surface forces which are the basis of the artificial nucleation of rain.

Properties of liquids. Further results have been obtained in the experimental and theoretical study of liquids and solutions, aimed at relating their structure with properties of importance in distillation. A new approach to the theory of simple liquids has been shown to give a satisfactory description of the critical region of density and temperature, where earlier theories were unsatisfactory. Similar methods are being applied to polar liquids and solutions. Detailed experimental study has been made of a group of solutions of polar liquids, including all possible binary combinations of acetonitrile, nitromethane, acetone, benzene and carbon tetrachloride.

Chemical effects of high pressure. Work in the high-pressure laboratory has again been centred on the problem of why pressure alters the rates and equilibria of

chemical reactions in the liquid phase. Concurrently with a theoretical attack, a number of experiments have been carried out to fill gaps in the existing data and to test the theoretical conclusions. The experiments have included the first measurements of the rates of simple free-radical reactions under pressure, and some determinations of the ionisation constants of weak electrolytes at pressures up to 12,000 atm. An apparatus has been designed to extend the pressure range to 45,000 atm. and some preliminary results have been obtained at that pressure. The apparatus makes use of a new and simple form of pressure seal which promises to be useful in other applications.

The bursting strength of thick-walled cylinders is a vital factor in the design of industrial high-pressure plant. A number of bursting tests have been carried out in the laboratory and the results show that, although there is a straightforward algebraic relation between the bursting pressure and the thickness of the cylinder wall, it is not at all of the kind required by the usual engineering formulae.

Flotation of tin ores. An investigation of the separation of cassiterite from the Maranboy ore by flotation has been completed. Tourmaline, which normally floats with cassiterite, has been satisfactorily depressed by silicofluoride, while the flotation of fine quartz has been minimised by controlling the ferric ion content of the pulp.

The development of a novel cleaning method in which flotation is coupled with hydraulic sizing has enabled 65% of the cassiterite to be recovered in a concentrate analysing 50% tin. This result was achieved in batch tests with no retreatment of middlings.

Rubber reinforcement. Studies on the reinforcement of rubber by carbon black have been continued, particular attention being paid to the mechanism of abrasion. In a series of experiments on heat-treated carbon black it was shown that there is a close relationship between the chemical characteristics of oxygen groups in the carbon surface (phenolic, quinonoid) and the abrasion resistance of rubber compounded with these carbon blacks. Iron, which is always associated with carbon blacks, appears to play a dominant rôle in this mechanism. It has been found that strongly bound iron affords protection against abrasion. Such iron may be present either in phenolic blacks prepared at low temperature or in semiquinone blacks prepared at 700°C.

Work is continuing on the characterisation of carbons used for industrial purposes.

Recovery of uranium from ore slurries

A new process of ion exchange has been developed for the direct extraction of uranium from an ore pulp and a pilot plant has been constructed and successfully operated.

The process may be operated batchwise or continuously. The essential feature, common to both, is the use of jigged beds of ion-exchange resins which behave like a fluid in non-turbulent flow. Pulps containing up to 40% solids may be passed through such a bed, but difficulties in removing sands from such dense suspensions have necessitated working with a pulp density of 20 to 30% solids.

In conventional practice, the feed pulp must be filtered or decanted, and a clear liquor only fed to the ion-exchange columns. More than 2% of the uranium is usually lost with the rejected solids. The resin-in-pulp process eliminates this step and the ion-exchange efficiency matches that of the conventional ion-exchange column. In both batch and continuous operation 99.5% of the uranium is recovered as a clear eluate five to ten times as concentrated as the feed pulp. Pulp flow rates of up to 2 gal./min./sq.ft. have been used through the adsorption column.

Conservation of water. Further information on the use of cetyl alcohol for reducing evaporative losses from water storages has been collected.

Laboratory experiments have provided a better understanding of the techniques required for efficient spreading of monomolecular films under field conditions, and of the influence of the degree of purity of the cetyl alcohol on performance.

Field trials made in collaboration with many public water authorities and private users have shown that the most important problems to be overcome when treating large stretches of water are attrition of cetyl alcohol and damage to the floating containers. Methods of combating these faults are being investigated. From small stretches of water up to about two acres in extent the process can be expected to reduce natural evaporation by 30 to 70%.

Nitrogen fixation. The utilisation of atmospheric nitrogen is thought to depend largely upon the activity of the enzymes nitrogenase and hydrogenase. Fifty-fold purification of the latter enzyme, obtained from the bacterium *Desulphovibrio desulphuricans*, has been achieved by a series of eleven procedures, five of which are additional to the previously published steps in hydrogenase isolation.

Tracer experiments with radio-iron and radio-cobalt fed to bacteria have shown that the most highly purified hydrogenase contains both of these metals. Although the purification is not complete, the result suggests that iron and cobalt are contained either in the hydrogenase or in an auxiliary enzyme, *i.e.* one which is necessary to the function of hydrogenase in the living organism.

Understanding of the properties and nature of hydrogenase has been extended by a comparative study of the mechanism by which molecular hydrogen combines in aqueous solution with a complex cyanide of cobalt. Kinetic evidence indicates that the active complex is cobaltous hexacyanide ion.

The work has led to the first detailed proposal of how bacteria hydrogenate nitrogen gas to ammonia at ordinary temperatures and pressures and in an aqueous medium.

GRAPHITE ANODES FOR CATHODIC PROTECTION

Corrosion annually costs industry millions of pounds in replacement or maintenance of buried or submerged metal structures. Most of this destructive corrosion can be prevented by the use of the impressed method of cathodic protection. The Morgan Crucible Co. Ltd. reports increasing use of *Carbinert* graphite anodes for the protection of metal structures against electrolytic corrosion. These anodes are rendered completely impervious by wax or resin impregnation to give the maximum possible working life in all types of soils and waters.

The anodes are available in sizes ranging from 2½ to 6 in. diam., in lengths up to 80 in. or to special order.

Transducers. Specification sheets covering a number of transducers, the associate power units, and the simple analogue computor have been produced by Evershed & Vignoles Ltd., Acton Lane Works, Chiswick, London, W.4. The transducers covered are for flow, pressure, differential pressure and level. Further specification sheets are being produced and it is expected that all Evershed processed control equipment will be covered.

INDUSTRY REPORTS . . .

Rubber industry progress

A government fiscal policy, which would do more to encourage research and re-investment at home, was called for by Mr. Reay Geddes, retiring president of the Federation of British Rubber and Allied Manufacturers' Associations and a director of the Dunlop Rubber Co., at the annual general meeting of the F.B.R.A.M.A. He pointed out that the rubber industry has a high rate of development and a high rate of plant obsolescence, and together with other industries so placed, it cannot rest content if competitors abroad are better treated. In order to achieve greater competitive power, the rubber industry had taken steps to supplement its traditional sources of raw materials to include synthetic rubbers and plastics.

Chemical company expansion plans

Special attention is being paid to the expansion of the existing research facilities of the N.V. Chemische Fabriek ' Naarden ' (Netherlands) and a start has been made on the construction of a new central analytical laboratory.

Future for synthetic fibres

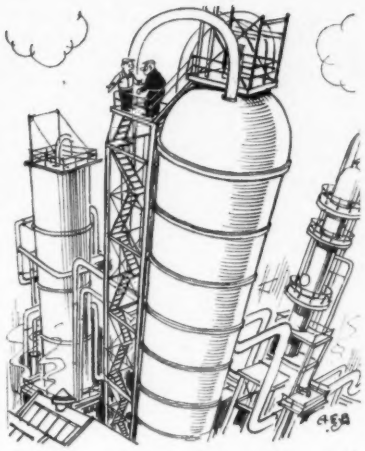
At the annual general meeting of Snia Viscosa (Italy), the chairman stated that the prospects of the Common Market were favourable for the group which, even now, exported three-quarters of its output. In the circumstances, its position would be even more favourable once it was able to acquire at international prices the raw materials, such as sulphur, which the Italian industry was at present forced to buy at double the price paid by its foreign competitors.

The chairman also outlined the future which he saw for man-made fibres and emphasised that, in his view, the cellulose fibre would remain the basis of the textile industry throughout the world. Synthetic fibres had but a marginal importance, but it could be said even now that the intrinsic qualities of *Rilsan*—the only polyamide fibre of vegetal origin—would ensure its future supremacy.

Oil gasification plants

The Gas Council reports that six new oil-gasification plants have been brought into production during 1956-57 and gas production from this type of plant increased by 16%.

New gas making capacity of 28 million cu. ft. was brought into use in the fourth quarter 1956-57. This made the total of new plant brought into use in the year up to 105 million cu. ft., compared with 104 million cu. ft. in 1955-56.



"BUT I THOUGHT YOU'D GOT THE TOOLS"

Chemicals in South Africa

In his annual statement, the chairman of African Explosives & Chemical Industries Ltd. said that the company's new plant at Umbogintwini for the manufacture of chlorine, solvents and plastics, which was started up in stages towards the end of 1955 and early in 1956, has since operated at less than its designed rate of output, due to market requirements being somewhat lower than had been anticipated and to a good deal of overseas competition at cut prices.

The older portion of the Klipspruit cyanide factory operated satisfactorily up to the limits of the methane gas available from the adjoining municipal sewage works. On the new extension at Klipspruit, which includes coal gasification and methane synthesis plants which were started up towards the end of 1956, some of the teething difficulties have still to be overcome, but it is hoped soon to get the new plant producing at a consistent rate.

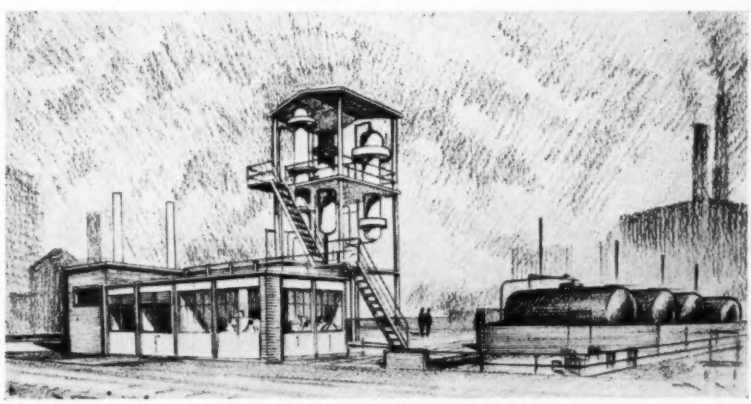
Ferro-manganese production

At the annual general meeting of Associated Manganese Mines of South Africa, Mr. B. L. Bernstein, who deputised for the chairman, announced a new enterprise to manufacture ferro-manganese in the Union. He said that a new company had been formed, known as Feralloys, Ltd.

CPE COST INDICES —LATEST FIGURES

Here are the two latest figures to be added to our cost indices (June 1949 = 100): Plant Construction Cost Index, May, **167.8**; Equipment Cost Index, May, **156.9.**

We regret that, in our last issue, the Equipment Cost Index for April was wrongly given as 258.7. This of course should have been 158.7.



REFINING HYDROCARBON OILS

An artist's impression of the plant for refining benzoles, naphthas etc., which is being built at the Thorncliffe works of Newton Chambers & Co. Ltd., by arrangement with the Coal Tar Research Association, and which is referred to elsewhere in this issue.

Technology Notebook

Research — Education — Discussion

Durham Colleges appeal

An appeal for £250,000 by the Council of the Durham Colleges was launched on June 17. The object of the appeal is to raise funds to begin a programme of expansion that is expected to cost at least £2 million to complete. The aim is to provide the necessary buildings and equipment, especially more laboratories and more residence for students, to bring the total numbers from the present figure of 1,300 to 2,000, and the numbers in science from the present figure of 400 to 1,000.

Grants to technical colleges

At their recent meeting the trustees of the Plastics Industry Education Fund made grants to a number of technical colleges, including the National College of Rubber Technology, the Borough Polytechnic, the Birmingham College of Technology and Acton Technical College.

Fish processing training centre

A training centre in fish processing, which will be attended by participants from the countries in Latin America, is being organised by the Food and Agriculture Organisation, (FAO), at the invitation of the Government of Peru and will be held at Lima from October 21 to December 14, 1957. The training centre will deal with the technology of fish handling, processing, preservation, salting, drying, canning, freezing, by-products, quality control and sanitation.

Data-processing section for S.I.T.

The Society of Instrument Technology is setting up a special section to cater for the current interest in data-processing systems. The section will begin to hold meetings in London this Autumn. Initial emphasis will be on systems for handling experimental data, and for industrial monitoring and control. The section will be concerned with system design as well as with the detailed design of equipment; it will also deal with the use and organisation of systems and with design-study work.

Non-destructive testing committee

In recent years the subject of the non-destructive testing of materials has achieved great importance. The formation, at this time, of a British National Committee for Non-Destructive Testing, is of considerable significance, particularly in view of the coming International Conference in Chicago in November, 1957. The need for a co-ordinating body has been clearly evidenced by the weight of the joint appeal for its formation, and by the widespread interest which has been shown in the exploratory discussions.

The British National Committee are inviting applications for membership from Institutions or Societies with an interest in non-destructive testing. The subscription is 5 guineas per annum. Each member society will be asked to nominate a representative who would take part in meetings of the National Committee. Applications, for the time being, should be made to the Secretary, Joint Committee on Materials and Their Testing, 1, Birdcage Walk, London, S.W.1.

COMPANY NEWS

At the annual general meeting of Fielden Electronics Ltd. it was announced that a major holding in the company has been purchased by Hopkinsons Ltd. of Huddersfield, the well-known manufacturers of boiler fittings and controls.

Mr. J. E. Fielden, the founder of the company, still retains a substantial shareholding in the company and will continue to guide its future as chairman and managing director.

★

The N.V. Chemische Fabriek 'Naarden' has announced that efforts to expand the company's production programme have led to the acquisition of all shares in the N.V. Jan Dekker Chemische Fabrieken, Wormerveer, The Netherlands. The existing facilities of Jan Dekker & Co. Ltd. include an electrolytic installation for the production of potash lye, as well as several modern installations for the splitting of fats, permitting the production of both fatty acids and glycerine. In addition, this company specialises in the distillation of glycerine as well as in the distillation of fatty acids, for which purpose important new facilities and installations have been provided during the last few years.

As far as the further development of Jan Dekker & Co. Ltd. is concerned, the board of directors of 'Naarden' intend that special emphasis shall be laid on those departments specialising in the field of fat technology.

★

Durham Raw Materials Ltd. have been appointed the sole selling agents in Great Britain for the products of Goodrich-Gulf Chemicals Inc. This change is by mutual agreement between the producers and the existing agents, British Geon Ltd.

The Goodrich-Gulf company is the largest U.S. producer of GR-S (general purpose synthetic rubber) and supplies all the normal varieties, including the newest oil extended grades, under the trade name *Ameripol*.

★

The Lord Mayor of Sheffield and the president of the Sheffield Chamber of Commerce were among the many industrial, professional and Governmental visitors to the Thorncliffe Works of Newton Chambers & Co. Ltd., recently.

During their tour of the Chemicals Division the visitors watched manufacture of toilet rolls in the *Izal* Products Factory and saw how modern machines of high capacity and efficiency are used. Here, too, they saw the bottling and packing of *Zal* and *San Izal* antiseptics and disinfectants. Some of the extensions recently completed in the *Izal* Factory to meet an increased demand for products are already in use.

★

Honeywell-Brown Ltd. have moved their Manchester Branch Office to substantially larger premises at: Warsall Road, Northenden, Manchester 22. They announce that the improved facilities are available for all enquiries concerning industrial instrumentation, heating and air controls, and precision switches.

★

It has been jointly announced by John Laing and Son Ltd. and the H.K. Ferguson Co. of Great Britain Ltd., that the two companies are forming a separate association in the name of Laing-Ferguson to provide a complete and comprehensive construction service to the chemical, processing, and manufacturing industries.

A GARDEN PARTY AT HAMPSTEAD

To mark the occasion of the 21st birthday of their twin daughters, Carol and Lynette, Mr. and Mrs. W. Leonard Hill gave a garden party at Hall Oak, Hampstead, on June 21. Here, amid the pleasant lawns and flower beds, and assisted by the senior staff of the Leonard Hill Technical Group (publishers of CHEMICAL & PROCESS ENGINEERING *and numerous other journals and publications), they entertained friends of the company, including a number of personalities in the chemical and chemical engineering industries.*

It was a charming, leisurely occasion, upon which the sun shone in full measure, tea being followed by a cake-cutting ceremony which brought some graceful speeches from the Misses Hill, and by cocktails, with musical and other entertainments combining to make a very memorable occasion.

Miss Carol (*nearer camera*) **and Miss Lynette Hill cut their 21st-birthday cake.**

★ Personal Paragraphs ★

★ Babcock & Wilcox Ltd., have announced the appointment to their board of directors of **Mr. I. M. Stewart,** and the **Rt. Hon. Lord Bridges.**

★ **Sir Nevil Macready,** BT., has been appointed manager of supply department of the Mobil Oil Co. He will report to **Mr. J. A. Paul,** who, since the beginning of this year, has carried out the dual function of director and manager of this department.

★ The new president of the Federation of British Rubber and Allied Manufacturers' Associations is **Mr. J. Frankenburg,** chairman of the Greengate & Irwell Rubber Co. Ltd., and vice-president of the Research Association of British Rubber Manufacturers.

★ **Mr. R. J. Knight** has rejoined Sheepbridge Stokes Ltd., a subsidiary of Sheepbridge Engineering Ltd., as sales manager.

★ **Mr. G. T. Collins** has been appointed to direct the operations of the Pennsalt International Corporation. Pennsalt's foreign operations include three chemical manufacturing plants and a fluorspar mine in Mexico and subsidiaries in Venezuela, Brazil, and Peru.

★ **Mr. D. Curtis,** development director of Quickfit and Quartz, Ltd., has been elected a councillor of the Society of Glass Technology.

★ **Mr. I. M. O. Hutchison,** joint managing director of the Balfour Group of companies, recently flew to America for a short goodwill tour. He visited New York, Rochester and Toronto, on behalf of various companies in the Group.

Mr. I. M. O. Hutchison.

★ **Mr. S. W. McCune,** eastern district sales manager of Du Pont Co.'s Elastomer Chemicals Department, has been named general sales manager of Du Pont Co. (United Kingdom) Ltd. His headquarters will be in London and he will be responsible for the overall sales activities of the new Du Pont subsidiary, now building a neoprene plant near Londonderry, Northern Ireland.

★ **Mr. A. T. Zodda** has been appointed vice-president-operations for Olin Mathieson International Corporation. He will be responsible for all overseas operations of the corporation.

★ **Mr. I. D. Davidson,** C.B.E., has been appointed to the boards of the Shell Petroleum Co. Ltd., and N.V. De Bataafsche Petroleum Maatschappij.

★ **Colonel D. G. N. Lloyd-Lowles** is the new chairman of the Amber Group of companies, of which he has been a director for some time. He succeeds the late **Mr. A. Mortimer,** who died in January of this year.

★ **Mr. M. Seaman** has moved from the board of British Oxygen Engineering Ltd., to the board of British Oxygen Gases Ltd., where he will be director responsible for equipment manufacture.

★ **Mr. J. R. Taylor** has been appointed Kelvin & Hughes (Industrial) Ltd. area engineer for the west of England. He has served 18 years with the company, the last two as area engineer in South Wales.

★ **Mr. P. L. Pocock** has been appointed general manager of the engineering division of Sheepbridge Equipment Ltd., a subsidiary of Sheepbridge Engineering Ltd. Before taking up this appointment he held the position of joint manager of Burnett & Rolfe, Rochester, Kent.

★ **Mr. A. H. Sands, Jr.,** was recently elected to the board of directors of American Cyanamid Co. to succeed **Mr. G. G. Allen,** who has retired from the board.

World News

FRANCE

Petrochemical firm to increase capacity

The French petrochemical firm, Naphtachimie, in which the French branch of the British Petroleum Co.—Petroles B.P.—has prominent interests, has announced an extensive programme to step up its production capacity.

The new programme is based on the erection of a new cracking unit at Lavera on the Berre Lake, near Marseilles, which would be able to produce an additional 30,000 tons of ethylene and 32,000 tons of propylene p.a. This would bring Naphtachimie's overall output to 48,000 tons of ethylene and 50,000 tons of propylene. This increase will be accompanied by development of production equipment for ethylene oxide and its by-products, particularly polythene.

The building of new plants for propylene oxide and its by-products, as well as a unit for the extraction of butadiene, are also foreseen as part of the development programme which will be completed before the end of the year.

PAKISTAN

Power alcohol from molasses

The Government of Pakistan is understood to be considering the use of power alcohol for admixture with petrol, and in this connection, the Premier Sugar Mills at Multan are building a distillery to produce power alcohol from molasses (at present wasted in considerable quantity from their sugar production). Equipment has already been purchased, partly from the United Kingdom and partly from the U.S.

CANADA

Petrochemical development

Canada's first continuous-process plant for the production of oil-soluble sulphonate—an additive that puts cleaning power in modern high-detergency oils—has been placed in operation by Surpass Petrochemicals Ltd.

The new $750,000 plant has an annual capacity of 5 to 7 million lb. of 60% active oil-soluble sodium sulphonates.

Two *Votator* multiport injection reactors eliminate the need for time-consuming batch operations, with a compact arrangement of automatically controlled continuous process equipment. The *Votator* reactors make the temperature control and process operation virtually automatic. The new plant will also be equipped to make other petroleum sulphonates, such as those containing lithium, calcium, barium, ammonia or amine.

ISRAEL

Negev development plan

A five-year plan for the development of the Negev, providing for an expenditure of I.L.400 million, has been worked out by the Israeli Government.

Phosphate mining is given high priority in the plan. According to the Minister of Development, rich new deposits of phosphates have already been located at 18 sites. Estimates of the Israel Mining Industries put the total reserves of phosphate rock in the Negev at some 200 to 300 million tons. Under the plan, the present output of 125,000 tons of rock p.a. is to be increased to one million tons p.a.

The Dead Sea potash production, at the Sodom plant, is also scheduled to be increased from the present monthly output of 7,000 tons to over 10,000 tons.

JAPAN

Synthetic rubber production

A semi-official synthetic rubber manufacturing company is expected to be formed soon, the Japanese Rubber Manufacturers announced recently. It would start production by 1959.

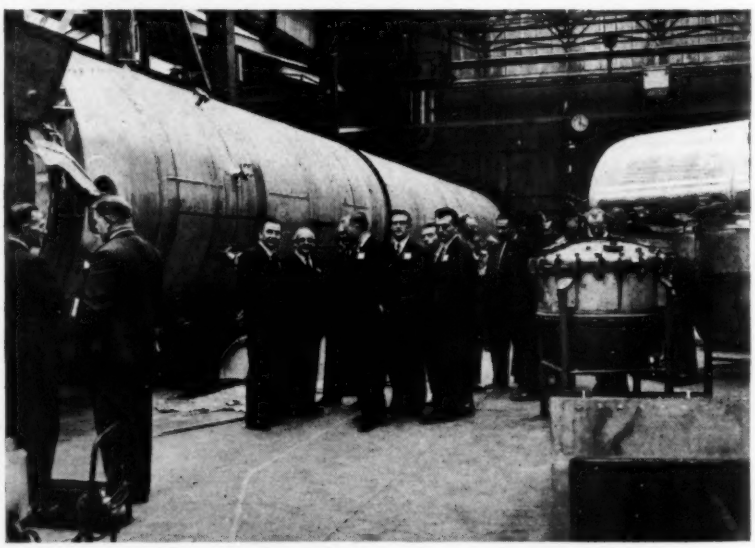
The company is to be organised under a special bill passed at the last session of the Diet. It plans to negotiate for manufacturing techniques from Goodyear, Firestone and other U.S. manufacturers. The present production schedule calls for the production of 30,000 tons of GRS and latex in 1959, 35,000 in 1960, 40,000 in 1961 and 45,000 tons in 1962.

Waste gas from oil refining will be used as raw material for the synthetic production. The total cost of building a synthetic rubber manufacturing plant—probably at Yokaichi, Central Japan—is estimated at 14,000 million yen.

Joint U.S./Japanese acrylic fibre plant

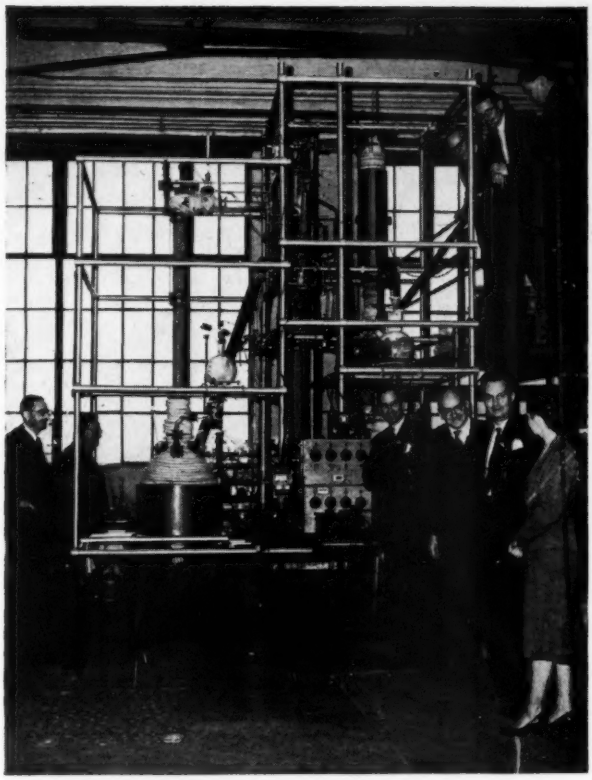
The Chemstrand Corporation and Mitsubishi Rayon Co. Ltd. are to form a company to make acrylic fibre in Japan. The new concern, in which Mitsubishi will be the majority stockholder, will be named Shinki Acrylic Fibre Co. Ltd.

The new plant called for in the agreement is planned to start output



CHEMICAL ENGINEERS VISIT FABRICATING SHOPS

Twenty eight members of the Institution of Chemical Engineers visited the works of The A.P.V. Co. Ltd. at Crawley, Sussex, on May 30 as part of the 'Joint Symposium on the Scaling-Up of Chemical Plant and Processes.' Here they are seen inspecting an 80-ft. aluminium extraction column made by A.P.V. for Laporte Chemicals Ltd. It is considered to be the largest aluminium vessel that has yet been made and is one of a number for a new plant at Warrington for the production of hydrogen peroxide.



TRIOXANE PREPARATION UNIT INSPECTED

Picture taken during the visit of delegates of the Society of Chemical Industry to the central research department of Brotherton & Co. Ltd., Leeds. Delegates are seen looking at the trioxane preparation unit in the pilot-plant shed. The parts for this unit were supplied by Q.V.F. Ltd.

with an initial rated capacity of 7,500,000 lb. p.a. Plans call for a later expansion to produce 15 million lb. p.a.

AUSTRALIA

New carbon black plant

A new carbon black plant, to meet nearly 60% of Australia's requirements, will be set up in Melbourne by two American firms—Godfrey L. Cabot Inc. and the United Carbon Co. Announcing this recently, Victoria's Premier stated that construction work would start immediately. The initial cost was estimated at A£1¼ million, with the total expenditure placed at some A£2 million. The plant will produce between 20 and 30 million lb. p.a. of carbon black.

MEXICO

New chemical plants

Sosa de Mexico, S.A., a new company formed in Monterrey, will produce 6,500 tons of chlorine and 7,300 tons of ' rayon ' grade caustic soda p.a. This company will also produce 3,000 tons p.a. of DDT.; it is hoped to begin production at the end of 1957. The Dow Chemical Co., through its recently acquired subsidiary, Sales y Alcalis S.A., is to set up a plant near Coatzacoaloos to produce alkalis, caustic soda, chlorine and derivatives.

Titanium dioxide

A £1-million titanium dioxide plant is to be built in Mexico by du Pont. Imports of this product at the moment are estimated to cost 30 million pesos p.a.

Sulphuric acid

Mexico now has 13 sulphuric acid plants with a total capacity of 194,000 metric tons p.a. This compares with an installed capacity of 63,145 tons in 1950. Production in 1956 was 161,483 tons and imports 2,628 tons: 58% of the production is used in the fertiliser industry. Consumption is expected to reach 240,000 tons in 1960, and at least three new plants are known to be planned which, between them, should give the necessary increase in capacity.

NETHERLANDS

Synthetic rubber project

The Royal Dutch Shell Co., has announced that it is considering building a synthetic rubber factory at Pernis, near Rotterdam. The factory, if built, will be the first of its kind in Holland. Dutch rubber manufacturers are increasingly using synthetic rubber and the percentage employed, which is at present 15%, is expected to rise further due to the marked growth of world rubber consumption and the difficulty of quickly raising the output of the natural product.

GREAT BRITAIN

Tower box purifier for Worcester

Work will start at the end of this year on a £135,000 tower box purifier to be installed at the Worcester Gas Works for the West Midlands Gas Board. Henry Balfour & Co. Ltd. have received a contract to erect this plant.

The tower box design consists of a large welded steel container subdivided into five towers. In each tower there are six trays holding oxide to remove sulphur impurities from the entering gas. This enters each tower through large connecting mains, passes through the oxide and is purified. The spent oxide is changed by a mechanical device which tips it from the trays, later re-charging them with fresh oxide.

Initially, the plant will have a total oxide capacity of 28,400 cu. ft., and the gas throughput will be 4 million cu. ft./day. Eventually, it is hoped to double this throughput by adding six further oxide-holding trays to the east tower. The installation is scheduled to be completed by the end of 1958.

Danish research reactor

Head Wrightson Processes have announced that they have been awarded a contract by the Danish Atomic Energy Commission for the design, engineering, procurement and erection supervision, of a materials testing reactor similar to those they are now building for the U.K.A.E.A. at Harwell and Dounreay. It is planned that the reactor will be completed before the end of 1959.

These reactors have the name *Pluto* and their counterpart, *Dido*, the most powerful experimental reactor in Western Europe, has now been in operation at Harwell for over six months. *Pluto*, like *Dido*, is an enriched uranium heavy water moderated reactor with a flux of 10^{14} neutrons sq. cm./sec. at a thermal output of 10 MW. The Danish *Pluto* reactor

will enable essential research to be conducted on the testing of materials under the effects of irradiation. The reactor will be erected at the Atomic Research Centre at Riso.

Germans see fibre recovery plant

Reed Paper Group mills in Kent, at Aylesford and Tovil, were visited on June 4 by six technical and legal representatives of the Water and Waste Water Committee of the federation of German industries—the Bundesverband der Deutschen Industrie. At present, a great deal of attention is being given in Germany to water and effluent problems because new, stringent legislation is being prepared, dealing with water abstraction and effluent disposal. The delegation's visit was to study the working of Britain's regulations in this field, and, at the same time, to study British methods of dealing with effluent disposal, and water conservation and supply.

At Aylesford, they saw in operation the first stages of a large scheme which will eventually settle all river water coming into the mills—the largest in Europe producing a variety of paper—and settle and recover fibre from all the effluents discharged into the Medway.

Big I.C.I. project for Severn-side

Imperial Chemical Industries Ltd. are seeking permission from Gloucestershire County Council to develop a site of 1,000 acres on the Severn, in the Thornbury Rural District, for the manufacture of organic and inorganic chemicals. If permission is granted, the total amount invested in developing the site between now and the mid-1970s may well be of the order of £100 million.

This ultra-modern chemical complex will employ the latest developments in chemical technology, and its plants will, to a great extent, rely on oil as their main raw material.

One of the factors influencing I.C.I. in their choice of the site has been the availability of good port facilities. Various oil products would be needed in large quantities for the operation of the processes planned. It is hoped that tankers of 30,000 tons capacity would bring oil direct from the oilfields and the refineries.

ARGENTINA

Giant investment

It is reported that La Forestal Argentina will invest 100 million peso in a quebracho extraction plant. Foreign investments reported recently have included U.S. $1,050,000 by the Watkins Investment Co., Philadelphia, to establish a plant in Argentina to manufacture *Cellophane*; U.S. $58,348 by the Worthington Corp. (U.S.) to make precision pieces for pumping equipment; and $58,789 by a French chemical company for a plant to produce rayon type caustic soda and gas and liquid chlorine.

UNITED STATES

New chemical plant for Union Carbide

Union Carbide Corp. is reported to be planning to build a major chemical plant in West Virginia. The company declined to say what the cost would be, but it is understood the total will be well over $50 million.

The plant, to be completed in 1960, will be the third major chemical plant of Carbide's in the area. It will produce raw materials for the company's plant at South Charleston and Institute, W. Va. Some of the important chemicals to be made at the new plant are ethanol, ethylene, propylene, ethylene oxide and isopropanol.

Nitrogen plant

The U.S. Steel Corp. has opened a nitrogen plant at its Provo (Utah) works, the first of its kind at a major steel facility, to manufacture anhydrous ammonia, nitric acid and ammonium nitrate.

New Anglo-American company

An agreement to organise a new company, Formica Ltd., in Great Britain, to be jointly owned by American Cyanamid Co. and Thomas De La Rue & Co. Ltd., of London, has been reached by representatives of the two companies. Under the terms of the agreement, De La Rue will transfer to Formica Ltd. its present plastics and resin business, including its factory at Tynemouth, England, and Formica Corp., of Cincinnati (a wholly-owned subsidiary of American Cyanamid) will transfer to the new company its trade mark *Formica* in all countries outside the Americas and certain territories in the Far East.

SOUTHERN RHODESIA

Minerals development

It is reported that about £500,000 has been spent on development at the Empress nickel claims near Gatooma, and that a mine comparable in size to those on the Copperbelt of Northern Rhodesia might be developed on the site. The pilot mill is reported to have cost about £60,000 and it consists of a small crusher, a ball-mill and 46 flotation cells with their ancillaries.

The Leonard Hill Technical Group—August

Articles appearing in some of our associate journals this month include:

Paint Manufacture—Epoxy Type Resins; Formulating with Chlorinated Rubber; Printing Ink Milling—Particle Size in Relation to Production Rate; Modern Trends in British Ink Making; Catalysts in Printing Ink Manufacture.

Dairy Engineering—Stainless Steel in the Dairy Industry; The Dairy Industry in Southern Asia, 1: India; Cleaning of Dairy Plant and Containers; Of Mice and Milk.

Atomics—Delft's Nuclear Reactor; Radiochemical Research in the Netherlands; Nuclear Energy Developments in the Netherlands Atomic Industry and Mechanical Engineering; British Automation on Show in Holland; British Protective Glass in Holland.

World Crops—Wild Oats; On Tour with a Logarithmic Sprayer; Lawns and Chemistry; Use of 2, 4, 5-Trichlorophenoxy Acetic Acid in Western Germany.

Automation Progress — Design and Uses of Hydraulic Servo Systems, 2; Numerical Control of Milling; Data Processing in the U.S. Army; D.S.I.R. Developments; The Inchworm Motor; Automation and the Operator; Data Reduction for Optimum Plant Efficiency, 2; Control Valve Characteristics.

Petroleum—The Geology of Australasia; Hydrocarbon Reforming in Relation to Town Gas Supply; Hydrogen Treating in the Refinery, 1; Viscosity Temperature Relationship; Oil Distribution in the United Kingdom; Research on Synthesis of Liquid Fuels in China; Canadian Oil and Gas Report.

Manufacturing Chemist — Production and Testing of Anti-polio Vaccine; The Chemistry and Structure of Insulin II; Glycerin in the Manufacture of Adhesives; The Chemistry of Carbon Dioxide; Progress Reports.

Food Manufacture — Pickering's Produce Canners; Nisin and Its Uses in Food Technology; Essence Manufacture—The Role of Electric Heating; Objective Criteria of the Hot Smoke-Cure Process; New Dutch Sugar Dryer and Cooler; Rapeseed Oil as Food; The Appert Institute of France; The Determination of Starch Purity with the Kent-Jones & Martin Colour Grader; When the Manufacturer is Liable.

Corrosion Technology—U.S. Tankers Freed from Corrosion; Cathodic Protection of Steel Underground; Instruments for Cathodic Protection; Cathodic Protection in Israel—On Land and on Sea; Zinc Anodes for Cathodic Protection.